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OF THE
Department of Agriculture
FOR THE YEAR
1948

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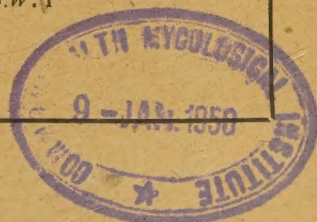


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Annual Report of the Department of Agriculture for the Year 1948

SECTION I—INTRODUCTION AND POLICY

The staff position in 1948 remained unsatisfactory, with vacancies for five agricultural officers and a second chemist still unfilled. The shortage of field staff did not allow expansion to be as rapid as could be wished, and in addition, the continued non-delivery of rice machinery, palm oil mills and palm kernel crackers severely restricted progress in crop-processing. With the formation of the Department of Commerce and Industry such work as crop-processing, produce inspection and marketing, hitherto carried out by the Agricultural Department will be gradually transferred to the new department. It is hoped, however, that the pioneer oil mill for Masanki oil-palm plantation and the large rice mill for the Scarcies will arrive in time to be established as going concerns before handing over to the Department of Commerce and Industry.

2. Apart from the delay in the programme for crop-processing, good progress was made in the established schemes and a certain amount of new work was introduced. Thus the basic policy of conserving soil fertility, by developing swamps for annual crops and leaving the uplands, as far as practical, for permanent tree crops, was continued in the mangrove and inland swamp clearance schemes, and the recently initiated improved oil-palm planting scheme. The distribution of seed of high-yielding swamp rice varieties, as well as planting material of improved varieties of cassava, yam and sweet potato continued as in previous years, with the result that all these crops are now widely established. Central nurseries were established in all districts to provide seedlings of the high-yielding Angola, Deli and Nigerian oil-palms. With the increased cocoa prices, reflected in a marked rise in exports, work in the cocoa areas was intensified and included organized drives against monkeys; a cocoa planting programme; and experiments in the fermentation of cocoa. Details were also worked out for the introduction of cocoa grading and inspection in 1949. The long-standing project for constructing the Giema-Zimmi road, persistently advocated by the department for many years as necessary for opening up the Kenema cocoa areas for development, was initiated by the Public Works Department. The year marked the inauguration of an Advisory Committee for Piassava, a product of peculiar importance to Sierra Leone in that it holds an exceptional position for quality in the World's markets. Small-scale copra production was also started, for the first time, in the Bonthe area. As regards work with rice, the main staple food of this country, the year was notable for the visit of the West African Rice Mission, the successful experimental use of tractor cultivation and mechanical threshing in the Scarcies, and the steady expansion of mangrove clearing, particularly in the Bonthe area. This latter extension amongst the farmers is now, after ten years of steady effort, providing a spectacular demonstration of pioneer farming by individual enterprise and reflects great credit upon all concerned, staff and farmers alike. The more recent inland swamp clearance scheme is also on sound lines and progressing well, especially in the Northern Province.

3. In connexion with livestock development, 1948 has seen the establishment of the new Animal Husbandry Station at Musaia, in the extreme north (Colonial Development and Welfare Scheme No. D 799). In the Colony area good progress was made in the breeding of European strain pigs at Newton, and in the establishment of several successful piggeries by local farmers.

4. In the field of research, considerable detailed investigations were carried out by the Agricultural Chemist (Colonial Development and Welfare Scheme R 17) into soil conditions in the Scarcies, Wellington and Maswari swamp reclamation projects. As a result, it is now possible to expand the areas under cultivation in the saline swamps at Wellington and Maswari and to allow local farmers to cultivate the

reclaimed land with good prospects of success. In the Scarcies, however, the successful production of rice in the experimental drainage areas at Rosino and Lu still elusive although prospects are improving. The Agricultural Chemist also carried out a preliminary series of fertilizer experiment at Njala and Newton on both upland crops and swamp rice; most encouraging results were obtained and it is expected the continuation of these experiments will provide information which will be invaluable in our efforts to improve soil fertility. Throughout the year the Entomologist, Plant Pathologist continued investigations relating to crop pests, whilst the Entomologist made further extensive studies of the habits of various species of Tsetse.

5. In the training of African staff, 1948 was notable in that, for the first time three members of the department were in the United Kingdom for further training. One is at Reading studying agriculture, one at Oxford taking a course in agricultural economics and the other is undergoing a year's horticultural training in Hertfordshire. Two others, Laboratory Assistants, were awarded scholarships for overseas university degree courses in chemistry and botany respectively but will have to postpone taking up their scholarships until 1949, owing to lack of space at the university. In addition, two of the Njala Training College agricultural students began a special course in science at the Prince of Wales School with the expectation of proceeding to degree courses in agriculture.

6. The year 1948 was, on the whole, an average one for food-crop production although heavy early rains were responsible for bad "burns" in some districts and a small reduction in upland rice production. Subsidiary food crops, however, were in good supply and there was no "hungry" season. Exports of agricultural products showed a further increase to a total of 76,961 tons as compared with 69,328 in 1947 and, for the first time are above the 1938 figure; the value was £2,351,920 as compared with £1,815,899 in 1947 and £614,232 in 1938. As in previous years, palm kernels formed the bulk of the exports, but there were notable increases as well in palm groundnuts and cocoa.

7. There has been no radical change in the general policy of the department. The following is the approved policy and an outline of the more important work initiated or extended during the year:—

A. THE ADEQUATE PROVISION OF FOOD FOR THE PEOPLE

This is to be accomplished by:—

- I. *The improvement and spread of swamp rice cultivation to such an extent that not only will the needs of the people be supplied in a bad year but there will be a surplus for export in ordinary years*

(i) *Mangrove Swamp Reclamation.*—This scheme, for developing mangrove areas where fresh water conditions are of sufficient duration to allow rice to be grown successfully without empoldering, was summarized on page 3 of the 1947 Annual Report, with detailed figures for the two districts, Bonthe and Moyamba, where the work is mainly concentrated. The position at the end of 1947 was that a total of 5,467 acres of mangrove had been felled of which 3,288 acres were actually under rice. During 1948, further extension was made in the Bonthe District and the total area felled had increased to 6,244 of which 4,156 acres were planted. New mangrove felling is estimated to be proceeding at the rate of about 500 acres per annum. In the Bonthe District 100 new loans were issued, but in Moyamba, pending the reorganization of the financing system to enable it to be managed by the Native Administration, no new loans were made. In Bonthe District, also, there was a notable increase in the number of farmers clearing on their own initiative. Altogether, since the scheme first started in 1938, loans have been advanced to 1,065 farmers. In addition, it is estimated that, in 1948, over 500 farmers were working without the aid of loans. The advantages of concentrating the work by grouping farmers together in the most promising areas are now becoming apparent in greater ease of supervision, prevention of monkey, bird and fish damage and in developing a corporate spirit amongst the mangrove farmers, who in every sense are pioneers in what must be one of the most exacting, Spartan, farming existences in the world.

(ii) *Saline Swamp Reclamation*.—In parts of the mangrove areas the stage has been reached where most of the more easily cultivable swamps have been taken up and further extension depends on the introduction of some system of empoldering and drainage which will permit the use of lands where the salt-free period is too brief to allow even short-duration rices to be grown by ordinary methods. Accordingly the results being obtained in the department's experimental polders at Maswari and Wellington, in the estuaries of the Ribbi and Rokel rivers respectively, are providing information which it is hoped will lead to plans for large-scale reclamation of saline mangrove swamps in the course of the next few years.

Experiments were started at Maswari in 1942 and at Wellington in 1945. Yields in the test plots at both places have been variable but with improvements in drainage, the use of short-season rice varieties and with time being given to allow salt conditions to disappear, yields have so improved over the last two years as to justify allowing local farmers into parts of the empoldered areas. This has been done at Maswari in 1947 and 1948, whilst at Wellington farmers started in 1948. The demand by local farmers for plots is keen and an extension of cultivation will be made in 1949. In 1948, the Agricultural Chemist continued the investigations which he began at Maswari and Wellington in 1947 and details are given in his report at page 25.

(iii) *Inland Swamp Cultivation*.—The cultivation of inland swamps, both for rice during the rains and for cassava, sweet potatoes and vegetables during the dry season, is now progressing steadily in most areas under its own impetus. Departmental propaganda, seed distribution and instruction in the technique of swamp cultivation over almost a quarter of a century are showing clear results. The development of organized swamp settlement is being increasingly made the responsibility of the Native Administrations, who bear the cost of initial clearance and rent the land in one-acre lots to individual farmers. This latter scheme was first started, in 1946, in the Makeni area, on a small scale. It has now expanded there and has spread to Port Loko and Kenema districts. The scheme is proving popular and is resulting in well-cultivated farms. It also proves, however, that in the early years of any such agricultural scheme it pays to start on a limited scale, giving close attention to detail. Figures of acreages cleared and planted under this scheme are:—

Circle				1946	1947	1948
Makeni	..	..	..	55	127	155
Rokupr	..	..	..	—	23	32
Kenema	..	..	..	—	64	54
Total	..	..	..	55	214	241

The scheme is going particularly well in the Kamakwie and Pendembu swamps in Makeni District and, with an average yield of 22 bushels of paddy per acre, the farms form an excellent visual demonstration. At Kamakwie in 1949, it is hoped to extend the scheme to include the upland surrounding the swamp, each individual unit to consist of two acres of swamp and two acres of adjacent upland. Each farmer will be encouraged to build his home on the upland of his unit. In 1948, a single model unit on these lines was established at Kamakwie as a demonstration.

(iv) *Swamp Rice Seed Distribution*.—In the years 1935–1946, over 93,000 bushels of seed rice were distributed for swamp planting, under a revolving seed scheme. With this scheme having served its purpose of getting large supplies of improved varieties into general use, and with other work occupying the attention of agricultural staff, it was finally discontinued in 1947. Distribution is now limited to that entirely under Native Administration control except for comparatively small quantities of seed of high grade selected varieties issued by the department usually on a direct sale or exchange basis.

II. The Better Cultivation of Inland Swamps for Crops other than Rice during the Dry Season.

Distribution of planting material of sweet potato and cassava and other crops suitable for dry season cultivation was continued from departmental stations and Native Administration farms. Particular attention is being paid to the dry season cultivation of the Makeni swamp "settlements" and in the Bonthe riverain grasslands. In the latter area the possibilities of mechanical cultivation for groundnuts and other crops in the dry season appear promising. Plans are being made to establish a tractor unit of 100 acres in 1950 at Subu, where the Sewa joins the Waanje River, whilst small hand-cultivated trial plots are to be established at a variety of points along both these rivers, with the intention of working out a practical scheme for dry season farming in this district.

III. The Extension of Garden and Small-field Crops to serve as an Auxiliary Food Supply.

Market gardening in the Colony area, around the larger towns and in the Kabala area continued steadily during 1948, whilst the cultivation of sweet potatoes and cassava in swamps in the dry season and on uplands during the rains is now standard practice practically everywhere. Yams continue to increase in popularity, and in the Northern Province pigeon peas are now grown on a field-scale in many places.

IV. The Improvement of Livestock

Cattle.—By the end of 1948 the establishment of the new Animal Husbandry Station at Musaia was well forward. Most of the buildings were completed including cowsheds, dairy, implement shed, workshops, dipping tank, rest house and staff and labourer's quarters. The transfer of stock from the former station at Teko, which remains the Veterinary Department headquarters, was completed by the middle of the year. At the end of the year the head of livestock numbered 57, all Ndama breed and all being bred for milk production. In 1949, it is intended to start a second herd which will be selected and bred for beef production.

In addition to breeding, the problems of cattle management and feeding under Sierra Leone conditions are being studied at Musaia. Whilst during this year of establishment there has been little opportunity for experimental work, records, started at Teko, have continued to be kept for the milk herd. In addition, a beginning has been made in collecting data on the carrying capacity of the natural grasses resulting after clearing and thinning orchard bush. It is interesting to note that since selection and breeding for milk was first started at Teko in 1944, the average yield of milk per cow per lactation has risen progressively year by year from 390 lb. to 1,225 lb. The average birth weight of calves has also shown a steady improvement from 30.3 lb. in 1944 to 38.1 lb. in 1948. Concurrently with these increases there has been a general all-round improvement in the health and appearance of the herd. These yields, although low by European standards, nevertheless do show that, within the limits of the breed, selected Ndama cattle can be improved in a comparatively short time by good management to yield a passable milk supply with a very high butter-fat content.

There is no question that under the relatively severe climatic and health conditions of Sierra Leone Ndama cattle are hardy. The health of the Musaia herd throughout the year was generally good although there were two outbreaks of Vaginitis. Treatment of the whole herd was carried out with satisfactory results. This disease, which seems common amongst local herds, has an adverse effect upon fertility and at Musaia the average number of services per conception rose from 1.1 in 1947 to 1.5 in 1948.

Pigs.—The rearing of pigs of European stock continued at Newton, Njala and Kenema. The main centre is Newton where pure-bred Large White and Large White crosses are kept under modern conditions and from which a steady supply of breeding stock has been distributed to a few selected pig-keepers in the Colony area.

From a recent census of the pig population in this area it would seem that what must once have been a flourishing industry is in danger of dying out. In 1841, the pig population of the Colony was quoted as 4,713; in 1938, this figure had fallen to 860 and in 1948 it was down to about 500 of which over half were from Newton stock. During the war the heavy demands for pork and the difficulty of obtaining sufficient pig-food caused a big decrease in numbers. It is not too much to hope that distribution of good breeding stock and the establishment on correct lines of successful pig-keepers since the end of the war has stemmed the decline.

Livestock Census.—The department co-operated with the Veterinary Department in a census of livestock throughout the country. The census was done in considerable detail but, even so, it was practically impossible to collect complete information. The figures, however, are probably accurate to within about 25 per cent. The totals obtained were:

<i>Cattle</i>	<i>Sheep</i>	<i>Goats</i>	<i>Pigs.</i>
58,307	11,474	29,394	3,766

Small Livestock.—Work was continued on a small scale with rabbits at Newton and Njala. Rabbits are being persisted with largely because local demand continues but, as yet, they cannot be called a success. They breed well and are comparatively easy to feed but they do not appear hardy, and mortality has been high at Njala, where, in the last two years, periodic outbreaks of Coccidiosis have had disastrous effects upon numbers. Guinea pigs at Newton did quite well during the year.

Poultry.—As in previous years, Rhode Island Red poultry continued to be reared to supply local demands both for eggs and breeding stock. Newton and Njala were the main centres. Production and distribution during the year from these centres were as follows:—

	<i>Eggs laid</i>	<i>Eggs Incubated</i>	<i>Eggs Sold for Hatching</i>	<i>Birds Sold for Breeding</i>
Njala ..	3,335	1,778	813	92
Newton ..	3,321	664	555	55
Total ..	6,656	2,442	1,368	147

In the totals of eggs laid and incubated and of birds sold this represents a general increase of up to a third upon the 1947 figures. Nevertheless, chick mortality, as throughout the past history of poultry development in Sierra Leone, remains excessive—over half the chicks which were hatched died during the year, largely due to disease. Until diseases can be controlled throughout the country it is unlikely that any great increase in either local African fowl or R.I.Rs. will occur. It is noticeable, however, that the Scarcies appears to be the one area so far comparatively free from disease and where stocks of local chickens and eggs are plentiful.

Attention at Njala and Newton has been paid, particularly since 1947, to the possibilities of ducks. The locally established breed, a Muscovy strain, has done well at both places on free range in and around the stockyards. They require little attention, are healthy and hardy, although at Njala there is a tendency to infertile eggs. At Newton it is intended to establish a commercial flock in 1949 to supply table birds for the Freetown market.

B. THE CULTIVATION OF MONEY CROPS AND THE EXPLOITATION OF WILD TREES FOR EXPORT PURPOSES

In 1947, export produce had begun to recover from the war years and in 1948, with the average prices for all oil-seeds and cocoa showing further increases, these

products had recovered and in some cases surpassed their 1938 tonnages. The following comparative table of export figures shows how the post-war years, 1946-1948, compare with the war and pre-war periods:—

<i>Products</i>	1938	<i>Average</i> 1939-45	1946	1947	1948
PALM KERNELS:					
Quantity ..	63,697	46,483	45,773	61,240	66,431
Value ..	£457,031	£381,081	£688,840	£1,301,742	£1,744,591
Price ..	£7	£12-£4	£15	£21	£26
PALM OIL:					
Quantity ..	1,066	426	107	637	2,208
Value ..	£16,025	£5,270	£4,449	£30,857	£115,958
Price ..	£15	£54-£11	£41	£48	£52
GROUNDNUTS:					
Quantity ..	Nil	—	—	24	890
Value ..	—	—	—	£506	£26,558
Price ..	—	—	—	£21	£30
BENNESEED:					
Quantity ..	374	197	127	3	350
Value ..	£3,700	£1,993	£1,999	£55	£11,538
Price ..	£10	£11-£9	£16	£18	£31
COCOA:					
Quantity ..	384	477	572	439	1,379
Value ..	£5,849	£8,741	£11,653	£16,930	£102,941
Price ..	£15	£22-£12	£20	£38	£74
COFFEE:					
Quantity ..	38	65	132	276	347
Value ..	£793	£3,319	£7,305	£15,137	£19,148
Price ..	£21	£129-£17	£55	£55	£55
KOLA:					
Quantity ..	1,450	997	1,307	2,300	1,840
Value ..	£29,785	£34,922	£105,470	£229,099	£166,633
Price ..	£20	£27-£41	£81	£99	£90
PIASSAVA:					
Quantity ..	3,791	2,338	4,118	2,958	2,158
Value ..	£40,369	£55,655	£236,352	£150,315	£88,343
Price ..	£10	£40-£10	£57	£51	£41
GINGER:					
Quantity ..	2,705	1,640	982	1,451	1,311
Value ..	£60,680	£53,533	£51,819	£71,258	£73,683
Price ..	£22	£54-£17	£53	£49	£56
Total tonnage, all exports ..	73,505	52,603	54,118	69,328	76,922
Total value all exports ..	£614,232	£544,514	£1,107,887	£1,815,899	£2,349,399

Note.—Quantities are quoted in tons. Prices are F.O.B., and in the case of 1939-45 are the maximum and minimum prices per ton during that period. Other years show average ruling prices per ton. These figures are all quoted from export statistics, the actual monetary value to producers would probably average two-thirds of the figures shown.

Noticeable features are the oil seeds, where a steady increase in price for palm kernels, palm oil, groundnuts and benniseed over recent years has brought about a corresponding progressive improvement in tonnage. In the case of groundnuts, which prior to 1947, had only been exported in negligible quantities from Sierra Leone, the 1948 figures, though modest compared with other West African exporting colonies are significant and are likely to be further increased in 1949. Palm oil, along with cocoa, has perhaps given the most spectacular jump in exports, both in tonnage and value.

The increased production of cocoa, which is centred in the Kenema-Pujehun districts, is a direct result of the big advance in price during 1948, £84 per ton being paid to the producer in the 1948-1949 season. Cleaning up of plantations, which had been more or less left derelict during the war years, and a certain amount of new trees coming into bearing, have also had their effect. A contributory factor has also been the campaign conducted against monkeys during 1948 in conjunction with the Administration in Kenema-Pujehun areas. These monkeys which have for many years been a major problem in the cocoa districts, are destructive to cocoa pods, a result being that many pods are damaged or become diseased and farmers are inclined to harvest pods before they are mature. Accordingly, with a bonus of 1s. per head being given for each monkey destroyed, an organised collective drive was made. The result was a total of 37,450 monkeys killed of which over 90 per cent were species destructive to cocoa. To keep the monkey population in the cocoa areas down to reasonable proportions this campaign may need to be repeated for several seasons. As a further step to increased cocoa production, Agricultural staff concentrated on getting farmers to extend their old plantations and to make new ones. A certain amount of new planting was done but the majority of farmers after experiencing several years of poor prices, appeared hesitant to embark upon any large-scale new planting. With two consecutive seasons of good prices, however, there are signs that planting will be more extensive in 1949.

Another tree crop—the most important to Sierra Leone both for export and local use—which is receiving organised attention, is the oil-palm. The three imported types, Angola, Deli and Nigerian have been established at Njala for many years and, on yield records, they have been shewn to be superior to the local wild varieties—Angola in particular yielding a greatly increased proportion of palm oil. Accordingly in 1947, a programme was formulated for raising seedlings of these varieties at central nurseries throughout the Protectorate and for group plantations to be started in 1948 comprising units owned by individual villagers. An initial transplanting of nearly 9,000 seedlings was done by farmers in 1948 in this fashion, whilst a further 15,000 seedlings were established in nurseries. Investigations at the 2,200-acre Masanki oil palm plantation, established by Government over twenty years ago, showed that the great number of self-sown seedlings there, would form a ready-made supply. Part of this plantation is Deli and the practicability of using self-sown seedlings of this variety for establishing plantations elsewhere will be tested in 1949.

As a secondary result of the coconut planting campaign carried out by the department in 1924-1929, copra-making has been started on a small scale in Bonthe District.

C. SOIL CONSERVATION

As in previous years the main underlying principle governing the whole work of the department has been the permanent objective of improving the fertility and productivity of the soil. To this end is directed the development of valley cultivation; the clearance and "settlement" schemes for inland, saline and mangrove swamps; investigations into the riverain grasslands; the substitution of permanent tree crops for annual crops in the over-farmed uplands; grass and fertiliser trials; and animal husbandry investigations. From the agricultural point of view, therefore, soil conservation in Sierra Leone is largely concerned with the better use of the land by intensive farming methods. Pressure on the uplands is beginning to be felt in certain chiefdoms, with a consequent decline in soil fertility there, which is causing a natural

movement to the swamps which is all to the good. In recent years, some chiefdom in the South-eastern Province and in Moyamba district, on the initiative of the Forestry Department, have been declared Soil Conservation areas, in which farming on specified hills is forbidden or controlled. Similarly, the early burning of grasslands has been adopted in a number of chiefdoms, mainly in the North. All these measures to check soil degradation, although as yet by no means general throughout the country are, nevertheless, welcome signs that the farming community is becoming increasingly aware of the need for positive action. In order to investigate and co-ordinate the sociological, agricultural and forestry aspects of soil conservation and to make recommendations, it was decided towards the end of 1946 to constitute a Soil Conservation team, consisting of an experienced Administrative, Agricultural and Forestry officer. Through various delays, mainly due to staff difficulties, the members of the team were not nominated until 1948 and will not be together until early 1949. The Agricultural Officer appointed to the team had extended leave during 1948 at Oxford to study Soil Conservation and related subjects.

D. THE IMPROVEMENT IN THE PREPARATION, QUALITY AND MARKETING OF PRODUCE.

The power-machinery ordered in 1947 for the mechanical processing of palm oil, palm kernels and rice had not been delivered by the end of 1948. This severely handicapped the plans for establishing a pioneer oil mill at Masanki oil palm plantation, the large rice mill at Mambolo in the Scarcies, and for testing out power-driven kernel crackers. The only arrivals during the year were certain parts of the pioneer oil mill and a few hand kernel crackers, which found a ready sale and have proved moderately satisfactory. Trials with a Ransomes "Pigmy" threshing machine gave promising results when used for paddy in the Scarcies area.

As preliminary experimental production of copra by sun-drying in the Bonthe coconut area at the end of 1947 gave an excellent sample, purchasing for export was started there in early 1948 and during the year three simple kilns, using coconut husk as fuel, were erected. This venture shows promise but, as the process is completely new to the coconut growers, progress is likely to be very gradual.

Towards the end of the year a series of cocoa fermentation experiments were undertaken in the Kenema cocoa area to obtain further data upon which to base instructions to farmers in the 1949/50 season, when it is expected that cocoa grading legislation will be in operation for the first time in Sierra Leone. The season was rather too far advanced when the experiments took place—in December—and all fermentation occurred during the harmattan period which was unusually early and severe. Results, although not conclusive, indicated that stirring and draining the fermenting beans were beneficial. An interesting point, also, was that lining the basket with "hay" as well as with banana leaves seemed to improve fermentation, possibly by acting as an insulator to the cool harmattan air. As far as could be judged, quantities as low as 50 pods gave, if anything, better results than larger quantities, whilst in one small test beans from four pods, only, were fermented in bamboo pots. In this latter test draining-off the liquor gave a significantly better result than in the undrained material. These two points, small quantities and draining the liquor, are important in native practice since most farmers only have small quantities of beans at a time to ferment, whilst it is usual to drain the liquor and use it as a pleasant drink. This series of experiments will be repeated on a more comprehensive scale in 1949, and will be started earlier in the season and completed before the onset of the harmattan. These first results, however, are very interesting and although as yet inconclusive it seems that the next step in field instructions to farmers is to concentrate upon getting them to stir their fermenting cocoa thoroughly and regularly.

In the piassava industry an innovation during the year was the formation of an advisory committee consisting of representatives of the Administration, Agricultural Department, producers and African, European and Syrian piassava exporters. Two meetings were held during the year, productive of many suggestions

for maintaining the high standard and increasing production of Sierra Leone piassava. Experience gained in the working of this committee will be invaluable if in the future similar bodies are formed for other products.

During the year the Produce Inspection Branch, although under-staffed, continued to function effectively and, despite the increased tonnage of export produce, complaints from overseas as regards quality of shipments were very few and limited to one or two consignments of piassava at the beginning of the year. The success of the inspection scheme is obvious in the general all round improvement in quality now seen at the ports as compared with that of two or three seasons ago. The storage of export produce in Sierra Leone still leaves much to be desired but, partly as a result of the good work of the Produce Inspection staff and better supplies of building material, there has been a distinct effort on the part of many traders to improve their stores, including the provision of better dunnage and ventilation.

With the formation of the Department of Commerce and Industry the functions of the Marketing Branch established in 1947 by the Agricultural Department were taken over by the new department at the end of 1948. During the year the Marketing Officer continued to assist in all matters relating to agricultural economics and also co-operated with the Development of Industries Board and the Economic Survey Committee.

During the year, also, a co-operative officer was appointed and arrived in the country. He worked in close contact with the Agricultural Department, and although in this first year organization and preliminary surveys formed the bulk of his work nevertheless it was possible, with the assistance of this department, for practical work to include the formation of two piassava marketing societies in the Lake Kwarko area. Here, conditions when first examined some two years previously, appeared most promising for such a venture to be started. It is a comparatively remote area with an alert farming community, skilled in producing a very high grade prime Sherbro piassava in marketable quantities on the shores of Lake Kwarko. Owing to the remoteness of the district there was a tendency for middlemen to under-pay for the piassava and to overcharge for consumer goods. Accordingly, the Co-operative Officer visited the area and, towards the end of the year, established two societies, at Mosenti and Topan, both of which have made a good start. The scheme, however, will need close attention during its first formative years if it is to be the lasting success it has every promise of becoming. The purpose of the societies is to organise wholesale marketing of inspected and graded high quality prime Sherbro piassava at the correct price, direct to exporters, and in return to obtain bulk supplies of consumer goods at correct prices. If successful, these societies should have far-reaching effects upon trading practices throughout the whole Bonthe area.

E. AGRICULTURAL EDUCATION

The training of future agricultural instructors continued at the Njala Training College, now in its tenth year. Here, training is given to educate both elementary school teachers, and agricultural instructors, the staff at the college being composed of members of the Education and Agricultural departments. To date, the college has provided 44 trained instructors to the Agricultural Department, in addition to 63 elementary school teachers and 14 junior forestry staff. During 1948 there were 19 agricultural students in residence, of whom 10 were new entries. The educational standard of this latter group was the highest so far admitted to the course, two students having London Matriculation and two the Cambridge School Certificate.

It is worthy of note that three members of the department are now in the United Kingdom on Government scholarships. Mr. J. A. C. Davies is at Reading University studying for the B.Sc. Agriculture and intending to specialize in animal husbandry; Mr. F. J. Short is taking a one-year practical course at Horticulture in Hertfordshire, whilst Mr. S. A. J. Pratt is at Oxford studying Economics. In 1949 it is expected that the two Laboratory Assistants, Mr. C. T. Pyne and Mr. J. O. Belford,

will take university degree courses in Botany and Chemistry, respectively. In addition, it is likely that the two first-year agricultural students at the Njala Training College who hold matriculation certificate will be given the opportunity and training to obtain the Higher School Certificate and, eventually, if successful, to be assisted to qualify in Agriculture at external universities.

With regard to co-operation in the teaching of agriculture and rural subjects in schools, this is largely confined to visits and advice by Agricultural officers and instructors to those elementary schools, throughout the Protectorate, which are endeavouring to maintain a school garden or farm. Emphasis during the year was laid upon establishing small swamp farms at some schools, but with varying success.

F. RESEARCH

Plant pathology, entomology and agricultural chemistry constitute the three branches of the research side of the department, with laboratories at Njala. Full details of work carried out are given under the appropriate sections of this report. Plans for establishing a major rice research station at Rokupr in the Great Scarcies River were approved by the Secretary of State and construction work, which will be financed by a grant from the Colonial Development and Welfare Fund, is expected to begin towards the end of 1949.

SECTION II—THE WORK OF THE AGRICULTURAL DEPARTMENT

(a) ORGANISATION AND STAFF

8. Mr. F. C. Dighton, Plant Pathologist, and Mr. H. Macluskie, Senior Agricultural Officer respectively, acted as Director and Principal Agricultural Officer when the substantive holders of these appointments were on leave. Mr. A. S. Kerton who had previously been seconded to the department as a Development Officer was, appointed to the post of Agricultural Superintendent. The vacancies for five agricultural officers and a second chemist remained unfilled, and the continued failure to recruit men for these posts has been a serious bar to progress. Apart from the appointment of six additional examiners in the Produce Inspection Branch there was no significant change in the junior technical establishment of the department.

9. For administrative purposes, the territory is divided into seven agricultural Circles each in charge of an agricultural officer and provided with departmental farms of varying size and scope. Experimental work and the bulk of extension work among the farmers are carried out by departmental staff, but with the development of the Native Administrations some of the more routine work of the extension services is being gradually handed over to them. The Native Administration farms, which increased to 35 in 1948, consist mostly of small farms demonstrating intensive valley cultivation and providing seed and planting material for distribution to local farmers. In addition an increasing number of Native Administrations are employing itinerant instructors to advise and assist farmers in the field. Details of some of the more important work done in the various circles are given in the following subsection:—

(b) AGRICULTURAL CIRCLES

South-western Circle

10. This Circle, with headquarters at Njala, comprises the three districts of Moyamba, Bo and Pujehun, a stretch of country some 130 miles long and averaging 40 miles in width. In the West it has a coastline extending from the Ribbi River, just behind the Colony peninsula, to the Sherbro estuary; whilst its eastern boundary is the Liberian border for a distance of some 60 miles from the coast. This Circle has a wide variety of crops, soils and agricultural problems. Thus, in the western creeks of Moyamba it has mangrove clearing and tidal swamp rice cultivation; in the east, around Sulima and Pujehun, the main industry is piassava; oil palms occur in most parts whilst localized areas grow ginger, cocoa and coffee. The livestock population of the Circle is low. The Headquarters of the Department and the central experimental station are at Njala. The Agricultural Officer, South-western Circle, is at present responsible for station work at Njala as well as for extension work throughout the Circle,

Experimental Station, Njala—Experimental work at Njala is chiefly concerned with measures directed towards the evolution of economic systems of stable upland farming to replace the present system of “shifting” or, more correctly, “bush-fallow” cultivation.

11. *Upland Grasses*.—Since 1944, various grassland trials have been in operation to ascertain the most suitable grasses for fallows and the best system of management in conjunction with the keeping of cattle; results in 1948 have confirmed previous conclusions that upon upland soil Guinea grass (*Panicum maximum*) is superior to elephant grass (*Pennisetum purpureum*) both for grazing and cut fodder. Comparative figures in cow-days per acre for the two grasses since they were first laid down in 1944 are:

		<i>Elephant grass</i>	<i>Guinea grass</i>
1944	..	151	291
1945	..	273	447
1946	..	80	243
1947	..	—	349
1948	..	—	315

By 1947 the Elephant grass was too poor to give satisfactory grazing but yielded 12,062 lb. of cut fodder per acre, and by 1948 it had almost died out completely and was discontinued; whereas, despite a severe dry season, Guinea grass continued to give good grazing. In addition, an acre of Guinea grass used for cut fodder has yielded the following figures:—

		<i>Yield (lbs.)</i>
1945	..	7,744
1946	..	17,358
1947	..	20,620
1948	..	12,670

Whether the decline in 1948 is due to the severe dry season or whether it indicates that the grass is past its prime and will continue to decline is not certain. Yields in the next few years should give further information on this point.

12. In order to compare different methods of grazing, one acre each of Guinea grass and Elephant grass was grazed at intervals of four weeks and six weeks, respectively in 1944 and 1945, whilst close planting, i.e. 10 ins., was compared with wider spacing at 1½ ft. and 2½ ft. With both grasses results were similar, there being no appreciable difference between the four weeks and six weeks grazing, but the closer planting gave more grazing. Grazing at fixed intervals, however, was unsatisfactory. It led to coarse cany growth and full benefit was not made of the grass whilst it was in the short succulent stage. Accordingly in 1946 the experiment was converted into mass-grazing *versus* single-animal grazing, with grazing intervals depending upon growth rate of the grasses and not at set intervals. Results in cow-days per acre since 1946 are:

	<i>Elephant Grass</i>			<i>Guinea Grass</i>		
	1946	1947	1948	1946	1947	1948
Single animal grazing	64	—	—	167	316	—
Mass grazing ..	96	—	—	320	382	325

It is clear that Guinea grass is better than Elephant grass and that mass grazing is better than single animal grazing. By 1947 the Elephant grass was suitable only for cut fodder and in 1948 could not even be used for that purpose. Guinea grass has maintained its grazing since 1946 but the single-animal grazed plot had become so coarse by the end of 1947 and regeneration was so uneven that in 1948 this plot was changed to mass-grazing. Under this treatment this plot soon improved and at the end of 1948 showed little difference from the original mass-grazed plot and during the year gave 305 cow-days per acre.

13. With Guinea grass established as the best upland grass, so far experimented with, new strains of this grass have been introduced in 1948. These were three from Queensland and one from Puerto Rico. Of the Queensland strains one had originally come from Brazil and the others from South Africa. The South American strains are similar in growth to local Sierra Leone strains but the other two from Queensland E.P.I. 8387 and E.P.I. 8389 are dwarf forms. These dwarf forms are most promising and are expected to give a better sward, as well as being less fibrous, than the local strain. They are being multiplied for extended trial. The other upland grasses which have been grown for observation since 1947 include the local *Pennisetum setosum* (formerly *P. polystachyon*) and *Setaria kasungula* from South Africa. Many other grasses have been tried but, after trial, have been discarded. *Pennisetum setosum* shows promise, its first measured yield, in 1948, gave 5,372 lb cut fodder in addition to 189 cow-days grazing per acre.

14. *Wetland Grasses*.—Of the various grasses tried in the wetlands at Njala since 1946, only Elephant grass, Guinea grass, *Axonopus compressus* and *Panicum laxum* remain as worth continuing with. Elephant grass which on the uplands has been a failure in comparison with Guinea grass, is outstandingly good for cut fodder as the following figures confirm:—

YIELDS IN LB. PER ACRE					
		Unmanured Plots		Manured Plots	
		Elephant Grass	Guinea Grass	Elephant Grass	Guinea Grass
1946	..	4,170	1,940	6,066	2,200
1947	..	12,072	2,696	29,952	13,064
1948	..	25,450	10,874	27,096	12,580
Total	..	41,692	15,510	63,114	27,844

The two local grasses, a broad-leaved *Axonopus compressus* and *Panicum laxum* both do well under wet conditions. Both are low growing, with *Axonopus* a creeping grass, and both form a thick mat of succulent herbage if grazed properly. Catt like these grasses which appear equally suitable for grazing and cut fodder. Preliminary yields per acre are as follows:—

		1947	1948
<i>P. laxum</i>	.. ..	96 cow-days grazing: 12,179lb. cut fodder	Not grazed: 28,436lb. cut fodder.
<i>A. compressus</i>	.. ..	—	188 cow-days grazing: 11,984lb. cut fodder.

15. *Leguminous Fodder Crops*.—*Pueraria phaseoloides* continues to be of great value as a fodder crop. Its high protein content and palatability to all livestock particularly to pigs, has been most useful. It withstands drought, is a good cover crop and makes excellent cut fodder or silage.

16. *Annual Crops*.—Most of the upland at Njala is occupied either by permanent tree crops or grass, the small area of arable land being now largely used for fertilizer and manurial trials by the Agricultural Chemist. Details of these trials are given in the Agricultural Chemist's report on page 25. In addition, plots of introduced yams and ginger were maintained for multiplication.

17. *Permanent Crops*.—Citrus, coffee and oil-palms form the bulk of the permanent tree crops at Njala and individual tree yields continued to be recorded. The manurial trial with Marsh grapefruit, started in 1946, had to be abandoned owing to several trees having to be removed as a result of citrus "scab." The established plots of Nigerian, Angola and Deli oil-palms are proving invaluable as sources of seed for distribution under the oil-palm planting scheme. In all, 62 bushels of oil palm seed were distributed during the year to nurseries throughout the country.

addition, seedlings are being raised at Njala and the first distribution to farmers has been made. Thus 1,212 seedlings were distributed to local farmers and 8,207 seedlings were transplanted to nursery beds ready for distribution in 1949. In addition to the distribution of oil-palms, the routine distribution of nursery stock of citrus, coconut, coffee, all types of fruit and ornamentals was continued on a considerable scale.

18. *Livestock: Cattle.*—The Ndama herd at Njala maintained good health until August when condition fell off badly. This may have been due to Trypanosomiasis, since Tsetse caught at Njala at that period showed a high rate of infection, but the animals showed little or no blood infection and did not respond to Antimosan treatment. Additional feeding was provided and by the end of the year the herd had improved to a reasonable condition.

19. *Pigs.*—There were indications during the year that the Berkshire strain at Njala was too inbred and a Large White boar was introduced. Posterior paralysis at suckling occurred to a certain extent amongst the Large White sows, and abscesses were too frequent. Feeding was difficult at times owing to the shortage of certain essential foodstuffs but an average weight of over 100 lb. at six months was maintained.

20. *Rabbits.*—There was a steady demand for rabbits as they are relatively simple to keep and breed well. Unfortunately at Njala, each year, there is a high mortality from coccidiosis.

21. *Poultry.*—The R.I.R. flock continued, with similar results to previous years, and although stock has been built up the heavy mortality amongst chicks makes poultry keeping here a doubtfully economic proposition. The demand for R.I.R. stock throughout the country will always continue, however, and the Njala flock is the main centre supplying this need. During the year 1,778 eggs were incubated and 813 sold for hatching whilst 92 young adult stock were sold for breeding. Ducks, as at Newton, continue to do well on open range and require little attention. An experimental shipment of Khaki Campbell eggs from the United Kingdom by air and by sea was unsuccessful.

22. *Extension Work—Inland Swamp Development.*—Propaganda continued in the Bo-Pujehun area to encourage the wet and dry season cultivation of swamps in preference to the over-farming of uplands. Unfortunately the early rains prevented good burns on upland farms and caused work to be delayed there. The time spent on swamp farms was therefore curtailed. Figures of swamp farms in Bo-Pujehun for the past three years are :

			1946	1947	1948
Number of farmers	..	..	3,085	5,694	4,244
Acreage	..	..	3,510	4,883	4,961

23. *Mangrove-clearing Loan Scheme.*—In this Circle, mangrove clearing is now largely confined to Bump Creek, a branch of the Krikuli Creek which opens into Yawri Bay just south of the Colony Peninsula. As mentioned in the 1947 Report the successful clearing and settlement of this particular creek is mainly due to the initiative and drive of one Chief with Temne settlers from the Scarcies. Assistance has been given by the department in the form of supplying seed of improved varieties, giving instruction in the transplanting system and arranging loans for mangrove felling. In 1948, short duration rice, distributed to farmers near the mouths of the creeks has enabled them to obtain a crop where formerly salt water made the season too short for rice growing.

24. Arrangements are being made for the mangrove loan scheme in this area to be taken over and run entirely by the Native Administration. Hitherto the Agricultural Officer and his staff have had to do this work but gradually more and more responsibility is to be given to the local authorities. It is noticeable, however, that in Bump Creek by far the greater proportion of mangrove farmers have cleared the man-

grove of their own accord, without any financial assistance, and it is not anticipated that any great increase in loans will be necessary to encourage further development. The last available statistics of mangrove clearing and settlement of rice farmers in the Moyamba area show that over 3,300 acres have been cleared, of which nearly 2,500 acres are planted with rice. This has been accomplished by some 600 farmers of whom two-thirds are unassisted by loans.

25. *Cocoa*.—With the marked rise in cocoa prices during the past two seasons, cocoa farmers in the Pujehun area have been active in clearing up plantations and a beginning has been made in new planting. There have been persistent complaints from cocoa farmers for many years that monkey damage has become excessive. Accordingly, in co-operation with the Administration, a four-day drive was carried out in early September in the Bo-Pujehun cocoa areas. A bounty of 1s. per head was given. The result was 12,817 monkeys killed, of which over 90 per cent were species destructive to cocoa. In consequence there has been an appreciable saving of crop, which is reflected in the increased export tonnage. This campaign, however, will need to be continued for some years if the destructive monkey population is to be effectively reduced for a long period.

26. *Oil-Palm*.—As part of the general improved oil-palm planting scheme for the whole country, nurseries of Angola, Deli and Nigerian palms were established at various places within the Circle. The large central nursery was at Njala with subsidiary nurseries at Sembahun and Pujehun. Three Native Administrations have also made a beginning in the same direction. During 1948, distribution from Njala was started and plantations made in the adjacent Kori Chiefdom; 1,200 seedlings of improved varieties were successfully planted by assisted farmers and by the end of the year less than 5 per cent. had failed.

27. *Piassava*.—The main production of the cheaper type of piassava is in the Pujehun-Sulima area. Work in this area during the year has mostly been instructions in better retting and preparation, so that the proportion of the higher grade prime Sherbro is increased. Producers in this area, however, are conservative and although in some places, notably at Fairo, there are welcome signs of success it is clear that general progress throughout the whole district will be slow until an officer is available to give concentrated attention to this work.

28. *Soil Conservation*.—For the first time in this Circle an appreciation of the dangers of over-farming hillsides and uplands has been shown by the people themselves. Under the guidance of the Forestry and Administrative departments, several chiefdoms in the Moyamba District asked to be made Soil Conservation areas and a programme of early burning of grasslands was formulated. The Agricultural Officer is co-operating in these measures.

SCARCIES CIRCLE

29. This Circle consists of the Port Loko and Kambia districts and covers the North-western portion of the Protectorate including the Great Scarcies, Little Scarcies and Rokel River areas and the coastal stretch from the French border to the mouth of the Rokel opposite Freetown. Headquarters are at Rokupr where a rice experimental station is maintained. This is to be enlarged under the Colonial Development Scheme into a major rice research station. A sub-station is located at Port Loko whilst there are seven Native Administration farms in the Circle. The main objective in this Circle is increased rice production. Three Native Administration swamp clearance schemes, including one mangrove area, have been started in recent years. Experimental drainage areas at Rosino and Luti continued, with further investigations by the Agricultural Chemist, and mechanical cultivation and water control trials. Nurseries have been established for multiplying improved oil-palms for distribution to farmers. Details of all work done in this Circle are as follows:—

EXPERIMENTAL STATION—ROKUPR

30. *Soil Toxicity*.—After giving an extended trial for several years to empoldering and water control it was decided, early in 1948, to allow the experimental rice blocks to revert to the normal free tidal conditions. A few bunded blocks were retained for chemical investigation and for various cultivation, water control and drainage experiments designed to test the effects of different systems of water control. On the land which was opened to free tidal wash there was rapid visible improvement in soil conditions which was reflected later in the yields. Results in the four small observation plots near the river, now in their third year of treatment, indicate that complete water control, as at present practised, is a failure and that free wash is necessary. More investigations, however, are needed with water control over limited periods before a definite conclusion can be drawn for or against partial control.

31. *Rice Selection*.—One hundred and thirty rice strains including local and imported varieties and their selections, were maintained. Selection by flowering curves and laboratory examination continued. Strict roguing over the past few years has regained the purity that was lost during the war years. During the year a key to the identification of many upland rice varieties was made. Rice varieties were received from Portugal, Portuguese Guinea, Bengal and Hungary, whilst varieties were sent from Rokupr to Burma, Gold Coast, Nigeria, North Borneo, Trinidad, Venezuela and Zanzibar.

32. *Other Crops*.—As in previous years improved varieties of yam, cassava and sweet potatoes were grown for multiplication and distribution. Nursery beds were made of Angola and Nigerian oil-palm seeds whilst some 1,000 Angola seedlings produced in 1947 were transplanted ready for distribution in 1949. The usual propagation and distribution of other economic plants and ornamentals continued.

33. *Livestock*.—The Ndama cattle herd at Rokupr numbered 22 at the end of 1948. The present herd dates from 1945, although a few cattle had been first introduced to Rokupr in 1936. The health of the herd is excellent there having been only one case of sickness, a few days digestion trouble in one cow, in four years. Feeding is entirely on grass throughout the year, with the addition of salt. The herd is providing an interesting demonstration that Ndama cattle can be maintained with the minimum of labour and with inexpensive feeding, under natural conditions on the Scarcies tidal rice lands.

EXTENSION WORK

34. *Swamp Clearance Schemes*.—In 1947, for the first time in the Scarcies Circle, the organised clearance of a small area, nineteen acres, of tidal mangrove swamp and 22 acres of inland swamp was done with the object of "settling" rice farmers. In 1948 these acreages were extended to 29 and 32 acres respectively. All expenditure on clearing, which was done under the direction of the Agricultural Department, was undertaken by the Native Administration. Each area is divided into one-acre lots rented from the Native Administration by individual farmers. So far yields from the cleared mangrove area have been good and, as in the Sherbro mangrove clearing scheme, are likely to ensure the permanent success of the venture. Yields from the cleared inland swamp area, however, were not good, although it is too early to state whether this is due to bad soil or to indifferent husbandry.

35. *Oil-Palms*.—A comprehensive oil-palm propagation programme, using Angola and Nigerian seed, was begun during the year. Main nurseries were established at Rokupr and Port Loko whilst four small ones were begun at Native Administration farms. By the end of the year 908 seedlings had been distributed and established, whilst nearly 9,000 seedlings remained in the nurseries for distribution in 1949. A survey throughout the Circle of small plantations of improved oil palms, established by the department in the past, showed some 2,000 trees in bearing. These are useful as a source of seed.

36. *Irrigation and Drainage Schemes.*—The scheme started during the year for large-scale reclamation of riverain areas in the Scarcies, failed in 1944 and 1945. As a result, from 1946 onwards, work has been confined to small-scale experimental areas at Rosino, Luti and Funkadeh. In 1946 and 1947 modifications were made in the water control system at the first two places whilst at Funkadeh breaches were made in the empolder to allow complete free tidal wash. At Funkadeh conditions for rice improved steadily in the area subject to tidal flooding. At Rosino and Luti however, conditions generally remained unsatisfactory although early-sown rice nurseries at Luti were quite good. In 1948, the Agricultural Chemist, in collaboration with the Public Works Department, introduced further modifications designed to improve irrigation and drainage at Luti and Rosino but although there was some improvement over 1947 in the growth of the main-crop test plots it was apparent, as expected, that satisfactory conditions have not yet been attained. A detailed account of the problem and plans for its solution are given in the Agricultural Chemist's report.

37. *Mechanized Farming.*—In 1947 it was shown that a wheeled tractor was unsatisfactory for swamp cultivation, since even when the surface soil appeared dry and hard the machine continually broke through this outer crust and became bogged down. Costs were therefore excessive and the work was slow. Early in 1948 a T.D. 6 diesel-engined crawler tractor from the United States of America arrived after a long delay. This was used at Rosino after a preliminary trial at Rokupr and proved a success so long as the caterpillar tracks were kept out of the open furrows. A Ransome's 3-furrow motrac plough was used, followed by two disc harrowings. The operations were completed with the minimum of stoppages and a satisfactory seed bed was produced over 48 acres at an operational cost of £1 8s. 9d. per acre. Additional mechanized equipment tried out during the year was a McCormick-Deering power drive reaper and binder and a Ransome's Pigma threshing machine. The latter operated successfully but the former has not yet been fully tested.

38. *Seed Multiplication and Distribution.*—Rokupr continued as the centre of production of pure rice seed for distribution to farmers throughout the Circle and to other stations. Intensive roguing since 1945 has, in most cases, regained the high purity of Rokupr stock which was lost during the war, whilst limiting the revolving seed scheme to about 500 bushels annually has further insured that only high grade seed is distributed to the farmers. Total rice seed distributed during the year was:

Revolving Seed Scheme	..	..	..	..	525 bushels.
Native Administration and departmental stations	..	..	..	..	203 "
Department of Agriculture, Gambia	..	..	..	..	534
Total	..	..	..	..	1,262 "

39. In addition, Port Loko sub-station and seven Native Administration seed farms distributed some 170 bushels of rice to local farmers but concentration at these places was made upon propagating improved oil-palms. Mosaic-resistant cassava and high yielding yam and sweet potato varieties continued to be distributed. An innovation at Rokupr is Passion fruit which is becoming popular there. Some plants have been distributed. It has the advantage of bearing fruit during the rains when other fruit is scarce.

40. *Rice Mills.*—The small No. 1 Planters mill at Rokupr, after being run by the Department for several successful seasons, was sold to a local trader during the year in order to encourage local African enterprise. In 1946 plans and estimates were made for a large rice mill to be erected at Mambolo on the Scarcies river. An order was placed early in 1947 but by the end of 1948 no delivery had been made. It is understood that whilst most of the milling plant is ready, the engine is not yet available.

South-eastern Circle

41. This Circle is the administrative South-eastern Province with its eastern boundary along the Liberian and French Guinea borders. The area is approximately 120 miles long by 50 miles wide and varies in character from the high rain forests in the South to the comparatively open highlands of the North. The southern half of the Circle is rich in oil-palms, whilst it also includes the main cocoa and coffee districts of Sierra Leone. Agricultural work in this Circle is therefore primarily concerned with the development of these three tree crops for export production and with inland swamp development to provide rice and other food crops for the people; the underlying principle in this work being the best economic use of the natural resources whilst simultaneously conserving the soil. The administrative centre is Kenema, where there is a small experimental station, whilst throughout the Circle, 21 Native Administrations have farms providing seed and planting material. In 1948 a new sub-station was established at Waiima in Kono mainly as a seed farm.

42. *Experimental Station Kenema.*—This farm is concerned in raising swamp rice seed, mosaic-resistant cassava, improved varieties of sweet potatoes and oil-palm seedlings, coconuts, banana suckers and other planting materials for distribution in the neighbourhood. It also serves as a training ground for Native Administration farm overseers.

43. *Extension Work—Native Administration Farms.*—In 1948 a total of £1,985 was voted by 21 Native Administrations for agricultural purposes. All of these administrations run small farms and employ Agricultural Demonstrators. These farms, however, are of variable success, depending mostly upon the interest shown by the tribal authorities. The best of them serve a useful purpose in providing demonstrations in swamp cultivation; in distributing seed and planting material and as centres from which assistance and advice are given to cocoa, coffee, and rice farmers.

44. *Cocoa.*—Large-scale drives against monkeys were made during the year in the nine principal cocoa-growing chiefdoms of Kenema, resulting in the killing of 24,633 monkeys, most of whom had become serious cocoa pests. Although this has not stopped damage entirely it has had an appreciable effect upon the cocoa crop. Instruction was given in cocoa fermentation and planting. The uniform high price, *i.e.*, 9d. per lb. to the producer, irrespective of quality, however, had no effect in improving fermentation, since, although the correct methods of preparation are now well-known to most farmers they naturally see little point in taking the extra trouble when no premium is given for quality. Whilst there was a certain amount of new planting it had by no means become general, and many farmers still appeared hesitant after the many years of poor prices.

45. *Coffee.*—Plantations, almost all of Robusta coffee, are a prominent feature of many villages in Kenema Circle and at present, with a guaranteed market price there is considerable activity in this industry. The Department has carried out tests in 1947-48 upon various hulling and pulping machines with a view to speeding-up preparation and saving labour. Mr. A. S. Kerton, Agricultural Superintendent, experimenting with a Grant's No. 1 "Planters" rice mill at Kenema, has shewn that it hulls dried cherry coffee very satisfactorily, economically, and with a product superior in appearance to the ordinary hand-prepared sample. A full-scale test is being made to work out the economics of coffee preparation with the rice mill and there is reason to believe that it may provide a solution to the African planter's manpower problem, increase production and at the same time give an economic return to the mill-owner.

46. *Oil-Palms.*—Some 3,000 Nigerian seedlings were planted out in one chiefdom whilst nurseries have been established to provide seedlings for future plantings.

Makeni Circle

47. This Circle, with headquarters at Makeni, comprises the Bombali, Kambia and Tonkolili districts of the Northern Province. The Agricultural centres in Makeni Circle are the main farm at Makeni, substations at Batkanu and Makali and Native Administration seed and demonstration farms. The first objective of all the farms is the utilization on proper lines of the inland swamps and adjoining upland. Within this framework work has proceeded now for many years, testing a wide variety of crops and multiplying and distributing planting materials of those most suitable for use in intensive systems of agriculture. Recently, organized inland swamp clearing schemes have been started at various points and show considerable promise, whilst in 1948 cattle ploughing was introduced into five Native Administration swamp farms for the first time. This Circle contains the only cattle plough farmers in Sierra Leone, a small compact group of Mandingo cattle owners who originally started ploughing in 1928-29.

Experimental Station, Makeni.

48. *Swamp Rice.*—The wet and dry season cultivation of the swamp and upland continued on the same lines as previously. Of the six swamp rices grown, D.C. 1 gave the highest yield. The British Guiana rices, No. 79, D. 99 and D. 114, all gave above-average yields and, on account of their short duration, are likely to be popular amongst local farmers. It is interesting to note that wet season rice has now been grown continuously in the Makeni farm swamp since 1941. In 1942 the average yield was 21 bushels paddy per acre. In 1948 the average was 26 bushels per acre, despite severe floods damaging some plots.

49. *Other Crops.*—Local and imported varieties of crops, such as cassava, sweet potato and legumes, suitable for dry season cultivation in swamps have been continuously tried out since the farm was first established. The result is that considerable information is now available upon which to base the extension of these crops amongst local farmers. During 1948 thirteen varieties of sweet potatoes, and twelve varieties of cassava were grown for comparison. With sweet potatoes, the habit of growth is important since the leaves form a widely eaten staple fresh vegetable. The general tendency is for the higher root yielders to have the poorer leaf growth and *vice-versa*. So far, Cameroon is outstanding for its leaf yield whereas Mississippi and three local varieties Director, Absika and Kadyanka are prominent for their tuber yields. Amongst the cassava varieties, Coco and Biriwa have both given excellent results, their yields being double that of their nearest rivals Makeni 5 and Mayugbe. Various legumes have been compared, some for swamp cultivation but most as upland rainy season crops. Pigeon Pea is expanding rapidly in the North as a popular pulse crop and in 1948 five imported varieties, including Pusa 69 and Hawaiian varieties, were under trial. Green Gram, for the third year in succession, has given very encouraging results both on the uplands during the rains and in the wetlands in the dry season, although, as yet, local farmers have shown little interest in this crop. Fruit-growing on the slopes surrounding the swamp farm has continued successfully with Smooth Cayenne pineapples and the banana plantation established in 1943 is doing very well. Banana varieties include Canary, Giminga, Santa, Pof and Man-of-war. The latter variety forms the bulk of the plantation which yielded at the rate of 10,000 lb. per acre.

Extension Work.

50. *Inland Swamp Development Scheme.*—This scheme, started in 1946 with funds from the Protectorate Mining Benefits Fund whereby individual lot holders rent one-acre plots from the local authorities, who are responsible for the original clearing, has continued successfully though gradually. In 1946 a total of 55 acres were allocated in this way in two Native Administrations. In 1947 this had increased to 127 acres in five Native Administrations and in 1948 to 155 acres cultivated by 116 lot holders in six Native Administrations. Average cost of clearing works out at just over £5 per acre and annual rent at 4s. 9d. per acre. The Agricultural Officer, Makeni, reports upon the scheme in 1948 as follows:—

"The schemes have continued to be successful, particularly at Pendembu and Kamakwie. The rice crops were generally good and it appears from the continued requests for schemes of this nature to be started elsewhere that the people are satisfied and are interested. Individual lot yields are not yet fully available but yields from specimen lots on all schemes show an average yield of 22 bushels per acre. In view of the apparent evenness of crops throughout the swamps before harvest it seems likely that the above figure is a reasonable average for all the swamps. There are cases where individual lot yields have been lowered due to damage done by "cutting grass", straying cattle, etc.

"Dry season cultivation of the swamps is increasing and is receiving every encouragement from the Department. Plans have been made for the upland bordering on the swamps to be brought into cultivation gradually by methods which aim at obviating erosion and maintaining the fertility of the soil. To this end an area around each swamp has been reserved and the bush allowed to regenerate. During 1948 a demonstration model holding of two acres upland and two acres swamp was established at Kamakwie out of funds (£100) provided by the Protectorate Mining Benefits Fund. It is hoped that the swamp Development Scheme at Kamakwie will be extended during 1949 to include use of the upland on the lines already indicated."

An advantage of these carefully planned, gradual schemes, is that from the beginning, innovations such as rice transplanting, dry season cropping of swamps, new crop varieties and cattle-ploughing, can be introduced under the close supervision which is essential in the early stages of any new development project.

51. *Oil-Palm Development.*—The establishment of African-owned plantations of oil-palms was first started in Makeni Circle in 1928 and continued into the early 1930's. It was not, however, until recently that this work has been revived and intensified. In 1948 considerable quantities of seed of Angola, Nigerian and Deli palms were sown at Makeni, the two substations and the ten Native Administration seed farms, whilst a new nursery for oil-palms was started at Mabonto. First distribution and planting of some 2,000 seedlings took place from Makali substation with only 1 per cent failure. Plans for planting on an increasing scale have been prepared for 1949 onwards.

52. *Distribution of Planting Material.*—The main farm, substations and Native Administration seed farms continued the production and distribution of planting material of a wide variety of crops but increasingly this is being made the responsibility of the Native Administrations. The Departmental revolving seed scheme, which since 1940 had been responsible for distributing 14,674 bushels of rice seed and 47,501 lb. of yam setts in Makeni Circle, was closed down in 1948, and future distribution will be from the Native Administration seed farms. This arrangement will enable Departmental staff to give more time to the swamp clearance and oil-palm planting schemes.

53. *Ploughing.*—During 1948, five Native Administration farms were supplied with ploughs and oxen for the first time, with encouraging results. In addition, the model holding at Kamakwie was also supplied and ploughing is expected to start there in 1949. Shortage of ploughs is preventing any extension amongst the established mixed farms in Biriwa Chiefdom but steps have been taken to improve this position.

Musaia Circle

54. This Circle comprises the Koinadugu District in the extreme north of the country and includes the main cattle area. Its centre is the new animal husbandry station at Musaia, funds for which are provided under the Colonial Development and Welfare Scheme. This station has taken the place of the livestock farm at Teko and is under the joint management of the Directors of the Agricultural and Veterinary departments. The main work of the station is to continue and expand the breeding, selection, cattle management, dairy and pasture work started at Teko. In addition Kabala sub-station, formerly in Makeni Circle, is now supervised from Musaia.

55. *Station Layout.*—Total acreage is 1,120. Preliminary work on surveying, clearing, farming, road-making, buildings, and water supply was started in 1944 and a first transfer of a few cattle from Teko was made. By the end of 1948 the building programme was well advanced, all livestock had been transferred from Teko and some 200 acres of bush had been cleared. Of this area 20 acres had been planted with crops and 52 acres fenced into paddocks.

56. *Cropping.*—The natural grass cover in the cleared area has provided the main cattle feed and this has been supplemented by groundnuts, cassava, sweet potatoes and green gram. Kono groundnuts yielded extremely well, giving 1,645 lb. of undecorticated nuts per acre, whilst green gram at 728 lb. per acre was also a success. A wide selection of local and imported grasses was under preliminary observation and multiplication and the most promising will be used to establish pastures and leys. A record is being kept of the number of cow-days per acre grazing provided by the paddocks. The vegetation of these paddocks is the natural cover after thinning and clearing orchard bush. So far, for the first rainy season the carrying capacity has averaged 37 cow-days per acre.

57. *Cattle.*—The transfer of cattle from Teko was completed successfully by May. The herd is entirely Ndama breed and consists of animals selected at Teko since 1944. Total at the end of 1948 was 57. These animals have been selected upon milk records but in 1949 it is proposed to purchase promising looking beef type animals from local herds and to start breeding separately for beef. Figures so far obtained from the established milk herd are:—

Year	Total Milk Production	Average per Cow per Lactation	Total No. of Cows Milked	Average No. of Cows Milked	Average length of Lactation	Average birth weight of Calves
1944	.. 10,136 lb.	390 lb.	26	8	152 days	30.3 lb.
1945	.. 12,356 „	722 „	16	9	203 „	34.1 „
1946	.. 13,955 „	1,077 „	18	8	337 „	35.0 „
1947	.. 15,925 „	1,108 „	18	9	294 „	35.4 „
1948	.. 16,917 „	1,225 „	21	10	235 „	38.1 „

In general the health of the herd was good, apart from two outbreaks of vaginitis. Treatment of the whole herd was carried out satisfactorily, although for a time the disease caused a loss in fertility.

58. *Dairy Products.*—The production of butter and cream was started in 1945 and Cheddar type cheese in 1947. Figures are:—

	Butter	Cream	Cheese
1945	.. 332 lb.	61 pints	—
1946	.. 239 „	62 „	—
1947	.. 266 „	67 „	57 lb.
1948	.. 567 „	31 „	72 „

Although this production is still on a small scale the experience and training gained in this work will be invaluable if and when it becomes possible to extend dairy work amongst local cattle owners.

Bonthe Circle

59. The area covered by this Circle is identical with Bonthe Administrative District. Its southern boundary is some 70 miles of coastline from the Turtle Islands to Messima, near Lake Mape. Its northern boundary is 30 miles from the coast and stretches from the Bagru Creek in the West to the Malen River in the East. Headquarters are at Bonthe, on Sherbro Island, and present agricultural work consists entirely of extension work, which is primarily concerned in increasing rice

production, and produce inspection. The extension work falls into three categories: mangrove clearing in the creeks opposite Bonthe; investigations relating to the agricultural development of the large areas of grasslands along the rivers Sewa, Waanje and Malen; and prime Sherbro piassava production in the lake areas in the eastern end. Supervision is almost entirely by waterways.

Extension Work.

60. *Mangrove Clearing Loan Scheme.*—Felling of new areas during 1948 is estimated at 567 acres, making a total of 2,942 acres felled since 1939 in Bonthe District. This figure is exclusive of felled areas, which for one reason or other have been abandoned. Of this total 1,681 acres are actually producing rice, the rest are in various stages of clearing. This acreage is being worked by 366 farmers assisted by loans and 100 farmers not receiving loans. During the year, loans totalling £328 were advanced to 98 new farmers and to two men with previous loans, making a total of 100 new loans. Work has gone ahead most rapidly in those chiefdoms where it has been possible to keep the farmers together. Thus, in one creek alone, there is now a continuous cleared area of some 350 acres. This method of settlement has the advantage of being easy to supervise, whilst damage from monkeys and fish is easier to prevent. A certain number of old farms have been abandoned and in most cases this has been due to their being isolated clearings.

61. *Riverain Grasslands.*—Early in 1948 the West African Rice Mission toured this area by air and by river. Its conclusions were broadly that if the flood waters of this area could be controlled and mechanical cultivation introduced on a large scale at least 50,000 tons of paddy annually could be produced here for export, sufficient to keep four large mills fully working. In addition the hydro-electric potentialities of this area were outlined. Capital costs, however, would be great. Whether or not the recommendations of the Commission are ever adopted it is still essential to collect as much technical information as possible concerning these grasslands. A beginning was made in 1947 when regular readings of flood depths were taken over the Subu area, where the Sewa enters the Waanje River, and at another place, Gbap. Details of native farming practices on the river banks were also obtained. Indications are that even under present conditions, with no flood control, it may be possible to develop dry season mechanical cultivation by tractor over large stretches of these flood plains. Accordingly an agricultural instructor was trained at the end of the year to drive a small British Anzani horticultural tractor. This was the only tractor available, but later it is hoped to try out large types as well. At present, dry season cropping under local practice is confined largely to rice and cassava. It is possible that maize, groundnuts and other crops may be successful and these will be experimented with on the ploughed area at Subu. Little is known of the soil properties of the grasslands although there is a rich layer of silt of varying depth deposited over large areas and the appearance of dry season local crops is excellent. It is hoped that as soon as possible a full-scale systematic soil survey will be made of the whole area.

62. *Piassava.*—Bonthe Circle, particularly around Lake Kwarko, continued as the chief area producing the high grade piassava known on overseas markets as Prime Sherbro. The quality, as a result of continuous instruction at producing centres and inspection at buying points, is now much improved. Tonnage, however, is still limited, due to such factors as manpower, the rival claims of high priced oil-palm products and inadequate communications in the piassava areas. In an effort to improve the latter problem organized clearance of overgrown channels has been started under the supervision of the Agricultural Officer. The first channel from Lake Kwarko to the Waanje river has been cleared enabling canoe transport to make a considerable saving of time and head portorage. The clearance of other channels is contemplated and in particular those going to the main raphia swamps. It is also intended, as soon as staff is available, to survey the main raphia swamps with a view to cutting channels into them. At present only the fringes of these swamps are

accessible to raphia cutters, with the result that the trees, here, tend to be over-
whilst the mature palms inside the swamps are left alone. Since mature trees produce
the best fibre anything that can be done to make them readily accessible will have
good effect upon piassava quality and, at the same time, enable producers to cut more
stalks and so step-up production.

63. *Piassava Marketing Societies*.—An interesting development which has arisen
as a result of visits by Departmental Officers in 1947 to the Lake Kwarko area
is the formation there, towards the end of 1948, of two co-operative societies.
From these first visits it was clear that many of the factors necessary to establish a successful
co-operative movement existed in this neighbourhood. Piassava producers were
centralized round the lakes, their product was of the highest quality and the farmers
appeared progressive and keen. Through remoteness from trading centres and lack
of competitive buying the people were not receiving correct market prices for the
piassava and, in addition had to pay excessive prices for the few consumer goods
which reached them. Accordingly, soon after a Registrar of Co-operative Societies
arrived in the country he visited the Kwarko area and established two piassava marketing
societies, one at Mosenti with twenty-one members and one at Topan with seven
members. So far this effort appears very promising but it will need close attention
particularly in these early stages.

64. *Oil-Palms*.—The Eastern and North-eastern parts of Bonthe district
are rich in oil-palms, all of the local low yielding types. As part of the general oil-palm
development programme, nursery beds of Angola and Nigerian seed were established
at Bonthe, Gbap, Yagoi and Tihun and arrangements were made to plant up areas
in the chiefdoms in the north of the Circle. There is keen interest throughout Bonthe
district in kernel cracking machines and several orders were placed for both hand and
power crackers. Unfortunately only one, a hand machine, was delivered during
the year.

65. *Copra*.—Most waterside villages in this district, as a result of large-scale
coconut planting under the aegis of the Department in 1924–29, are rich in coconut
palms, those nearest houses bearing excellent crops. There is a ready demand for
coconuts in the larger towns and up-country. This demand keeps prices of fresh
coconuts, for the most part, above the economic price for copra making. Nevertheless
copra making on a small scale was started in the 1947–48 dry season at Gbap and
a limited quantity of excellent quality material was sold for export. During 1949
small drying kilns were erected at Gbap, Kale and Taigbe and instructions in copra
making were given.

Colony Circle

66. This circle, with headquarters at Newton, comprises the whole of the Colony
including Freetown, as well as the Koya Chiefdom of the Protectorate. Its northern
boundary is the Rokel River and its southern boundary the Ribbi River. It is mainly
concerned with the development of intensive production of food crops, fruits, livestock
and poultry amongst the smallholders and market gardeners who supply the
needs of Freetown and its suburbs. Its chief experimental extension projects are the
reclamation of saline mangrove swamps in the creeks near Freetown and the establishment
of piggeries amongst Colony farmers.

Experimental Station, Newton.

67. The soil of this station is representative of a large part of the Colony upland
area, consisting of poor sandy soil carrying a mixture of low bush, oil-palms and
Chasmodium grass, with lalang grass establishing itself as a serious weed following
cultivation. The farm policy which has been developed during the past ten years is to
combine stock farming with intensive valley cultivation, at the same time devising an
anti-soil erosion technique and the establishment of economic tree crops on the upland
area. In this period, a small herd of Ndama cattle, a flourishing pig unit, flocks
of Rhode Island Red poultry and Muscovy ducks, rabbits and Guinea pigs have been
built up. Valleys have been terraced for intensive cultivation, and dammed for
irrigation during the dry season. A variety of tree crops including citrus, mango

avocado, cashew, cinnamon and Angola oil-palms have been established on the uplands. It has become apparent that to grow any kind of annual crops successfully on the poor Newton soils liberal dressings of farm-yard manure or compost are essential.

68. *Pigs*.—At Newton, since 1945, commercial rearing of English pigs of predominantly Large White strain has proved itself easily the most profitable line in the farming system evolved here. During 1948, ten boars and nineteen sows and gilts were distributed for breeding purposes, whilst 76 animals were sold for slaughter, the total revenue amounting to £1,100. In addition the pig manure has been of increasing value to the valley market garden and upland fruit trees. The full economic development of the Newton piggery, though, has yet to be reached. Feeding at times has been difficult and has had to depend upon the type and price of food available rather than upon an ideally balanced diet chosen from a wide variety of plentiful foodstuffs. Also amongst the pigs there is a tendency to weak bone structure, primarily thought to be due to mineral deficiency. At present this factor is responsible for rather more culling than should be necessary. When it has been remedied the Newton piggery may show its maximum production and profit but meanwhile it is a most successful concern and is beginning to have a marked effect upon the rural economy of the Colony area. Several local piggeries have been established successfully with stock from Newton during the last few years and in 1948 one man alone supplied 60 pigs to the Freetown Cold Storage Company.

69. *Cattle*.—The herd of Ndama cattle maintained at Newton since 1941 continued to thrive. With continuous selection and good management some improvement has been achieved but as economic producers of meat or milk the Ndama breed leaves much to be desired. Its chief merit is its hardiness and tolerance of Trypanosomiasis. At Newton the herd is invaluable as a source of much needed organic manure.

70. *Poultry*.—Breeding and distribution of R.I.R. stock, started in 1940, continued in order to supply the persistent demand in the Colony area for birds and eggs of imported strains. Periodic outbreaks of fowl pox and typhoid, infertile eggs, heavy chick mortality and rapid degeneration of stock, requiring frequent new introductions are seemingly insurmountable obstacles to an early large scale poultry improvement. With ducks, however, prospects appear more promising and during 1948 the Muscovy flock increased rapidly and maintained excellent health, under farmyard conditions. In 1949 it is hoped to expand this line commercially by supplying the Freetown market.

71. *Small livestock*.—Rabbits and guinea pigs on a small scale, continued to be bred quite successfully and local interest in rabbits is increasing.

72. *Crops*.—*Valley Cultivation*.—The two intensively cultivated valley smallholdings, started at Newton in 1941 as demonstration to the Colony market gardeners, were continued during the year. These smallholdings which are designed to produce rice in the rains and vegetables under simple irrigation during the dry season, with fruit of all types on the terraced slopes, are now in a high state of productivity. Varieties of all types of those crops which have been proved by experience to be best for this type of farming are now well established at Newton, whilst promising new lines are continuously being tried out. The rice variety D. 114 continues to be outstanding as also do the pineapple varieties "Smooth Cayenne" and "Baron de Rothschild."

73. *Upland Cultivation*.—The upland soil at Newton, typical of most uplands in the Colony area, is degraded. Since 1945 various methods including contour ridging composting, manuring and laying down to grass have all been tried but it is clear that to produce annual crops such as cassava, yams and cowpeas, such heavy dressings of farmyard manure or compost are needed as to be uneconomic. Guinea grass and *Andropogon gabonensis* have been established as the most successful "pasture" grasses so far tested, although on this poor soil it is not easy to maintain a first-class stand. Under these conditions *Andropogon gabonensis* stands drought better. *Setaria kasungula* is also a promising, palatable grass.

74. *Economic Tree Crops.*—The nursery for fruit trees supplied budded citrus and mango as well as a variety of fruit seedlings to meet local requirements. Established fruit trees on the farm produced satisfactory crops, particularly Marsh Grapefruit, Genoa and Villa Franca lemons. Mango trees flourished, but Avocado pear trees showed marked deterioration, again indicating that regular manuring is required if these trees are to bear satisfactorily under Newton conditions. Cashew trees, when not growing too thickly, thrive well, demonstrating the possibilities of this crop on poor sandy soils. Deli and Nigerian oil-palm nurseries were made during the year. Seedlings of Angola oil-palms, transplanted from 1945 onwards, have suffered badly from termite damage in the early stages and various treatments are being tried on the advice of the Entomologist.

75. *Chemical Investigations.*—During the year the Agricultural Chemist conducted experiments at Newton to study the effects of fertilizers, green manure and compost upon rice grown in poor swamp soils. The establishment of *Pueraria* on poor upland soil using various fertilizers was also studied. Full details of these experiments will be found in the Agricultural Chemist's report.

76. *Reclamation of Saline Swamps.*—There are two cleared saline mangrove areas, Maswari and Wellington, both supervised from Newton. Investigation continued at both places to perfect a system of rice growing which if successful could be applied to large areas of saline mangrove swamp in Sierra Leone.

77. *Maswari.*—This was originally started in 1938 as a ten-acre empolder of *Avicennia* mangrove situated about half-a-mile from the Ribbi River, near its mouth. These ten acres were bunded and had complete water control. Results indicated that a period of several years cultivation after the original felling was necessary before good rice crops could be expected; that bunding had to be used with discretion and that drainage had to be adequate. Results were sufficiently promising to justify empoldering a further 75 acres in 1945. In this extension, small test plots were cleared of mangrove and have been planted each year with rice. In addition, in 1948 an half-acre trial plot on the banks of the Ribbi River, where there is good natural drainage, was cleared and grew a good crop of rice without an empoldering. Two varieties, Sughandi and D. 114, both comparatively short duration rices, have proved very suitable for this work. In 1947 and 1948, local farmers cultivated six of the original ten empoldered acres and obtained successful crops varying from ten to twenty bushels per acre, depending upon the farmer's methods. In 1949 it is proposed to allow fifteen acres of the extension area to be farmed by local farmers.

78. *Wellington.*—This experimental area of cleared mangrove is immediately adjacent to the Rokel estuary east of Freetown. Originally cleared by the Forestry Department to supply firewood, it was partly drained, towards the end of the war, by the Medical Department as an anti-malarial measure. The Agricultural Department started the experimental cultivation of rice, here, in 1945 after a sea wall empolder had been constructed and drainage channels dug. As at Maswari it has taken several years to remove the salt and to perfect the drainage and bunding system. Toxicity developed and preliminary chemical investigations were started in 1944. In 1947 and 1948, in an effort to improve soil conditions, the Agricultural Chemist carried out intensive field experiments at Wellington involving variations in drainage and cultivation, and treatment with lime in the form of burnt oyster shells. Full details of this work are given in the Agricultural Chemist's report on page 25. One test plot had given a consistently high yield since 1945 and although other plots had given indifferent to bad yields, it was obvious that rice could be grown given the right technique, water regime and soil conditions. In 1948 prospects had improved sufficiently to warrant some ten acres of the reclaimed land being rented to fourteen local farmers. These men obtained an average yield of 1,110 lb. paddy per acre, with a maximum in one case of 1,620 lb. per acre. In 1949 it is proposed to allocate

a further twenty acres to be cultivated by local farmers. Meanwhile chemical investigations will continue and, with the information gained in this direction and in improved cultural and drainage operations, there is every possibility that the problem of utilizing the saline swamps in the environs of Freetown will be solved satisfactorily and permanently in the not too distant future.

(c) RESEARCH

PLANT PATHOLOGY SECTION

79. The Plant Pathologist, Mr. F. C. Deighton, O.B.E., acted as Director of Agriculture from 15th May to 15th October, and proceeded on leave on 11th December. Mycological work was therefore largely confined to routine collection and identification and advice on problems of plant diseases, though several new contributions to the knowledge of local plants and fungi have been made. The Plant Pathologist reported as follows:—

- “1. New fungus or host records for Sierra Leone included: *Asterina parinari* Syd., on *Parinari subcordata*; *Cercospora longissima* Cugini apud Traverso, on leaves of old lettuce plants; *Cystopus candidus* (Pers. ex Chev.) Lev., on radish at Kabala; *Helminthosporium leucostylum* Dreschler, on *Eleusine indica*; *Helminthosporium sacchari* Butler, on *Cynodon dactylon*; *Lembosia lophirae* Syd., on *Lophira procera*; *Meliola interrupta* Hansf. & Deight., on *Dracaena godseffiana*; *Meliola vicina* Syd. var. *minor* Hansf. & Deight., on *Sabicea discolor*; *Pseudoperonospora cubense* (Berk. & Curt.) Rostew., on *Sphaerosicyos? sphaericus*; *Puccinia heterospora* Berk. & Curt., on *Sida rhombifolia*.
- “2. Publication: Hansford and Deighton: West African Meliolineae II; Commonwealth Mycological Institute, Mycological Papers, No. 23, 1948. (202 species and varieties of this group of fungi, mostly from Sierra Leone, have been identified, 107 of which were previously undescribed.
- “3. Sixty-five collections of fungi and over 250 collections of flowering plants (including several new records for Sierra Leone) were made during the year and despatched to the Commonwealth Mycological Institute and the Royal Botanic Gardens, Kew, respectively, duplicates being placed in the Herbarium at Njala. Collecting was particularly directed to certain families of flowering plants hitherto poorly represented in the Njala herbarium and inadequately known from Sierra Leone.”

AGRICULTURAL CHEMISTRY SECTION

80. The Agricultural Chemist, Mr. H. W. Dougall, reported as follows:—

STAFF

1. There has been no change in the staff of the Chemistry Section during the year under review. Vacancies still exist for the posts of Laboratory Assistant and Laboratory Attendant. The lack of trained assistants has inevitably caused laboratory work to lag far behind field investigations.

STORES AND SUPPLIES

2. The unavailability of necessary chemical reagents has been a constant handicap and it was not until last November that the position began to show definite signs of improvement.

SCOPE OF WORK UNDERTAKEN

3. The programme of work included the introduction of practical measures to combat the retrogressive soil changes which have occurred in Alluvial (mangrove swamp) soils and Gley-Alluvial (grass-sedge swamp) soils where such soils had been empoldered for rice cultivation; studies on some native agricul-

tural practices and on certain aspects of such practices, when modified; studies on the use of fertilizers to establish leguminous cover crops and on the application of fertilizers to root crops, a cereal crop and forestry seedlings; the collection of geological and other data required in connection with soil surveys which must be carried out in the future, and certain routine analyses of water, crops and plant products.

VISITS, ETC.

4. In February, the Agricultural Chemist made a four-day tour of rice areas in the Gambia and from thence he went to Portuguese Guinea. The object of this latter visit was to study the general methods employed in that country in the reclamation, for rice cultivation, of their deltaic Alluvial (Avicennia mangrove) soils. A report on the results of this visit has been made previously.

5. In June the Agricultural Chemist attended the conference at the Rothamsted Experimental Station on "Sub-Tropical and Tropical Soils". The resolutions of this conference were submitted to the Sierra Leone Government.

6. Details of the work undertaken during the year follow hereunder:—

SOIL RECLAMATION FOR RICE CULTIVATION

7. *Tidal Swamps*.—In certain areas along the Great Scarcies River development schemes were introduced to increase food production—during the emergency of war—by reclaiming, by empoldering, the water-logged, grass sedge Gley-Alluvial soils, (which occur immediately behind the Alluvial soil of the river's flood plain), and bringing them into cultivation for the growth of rice. At the Rokupr Rice Station a large portion of the farm which is situated on the flood plain of the Great Scarcies River, was also empoldered.

8. No geological survey, surface geology survey or soil survey preceded the initiation of these schemes, presumably on the account of necessary technical officers not being available to carry out this preliminary work. Ecological surveys were made in all areas and regard was paid, as far as possible, to probable difficulties arising during and after reclamation, e.g. soil salinity problems, drainage problems, flooding problems, etc.

9. Important aspects of the general problems however did not receive the attention which they merited, particularly with regard to—

(i) the growth requirements of rice plants;

(ii) the necessity for achieving rapid and efficient irrigation as well as rapid and efficient drainage.

10. The possibilities of creating soil changes inimical to rice growth did not appear to have ever been contemplated; indeed it would be difficult to visualise the precise nature of what chemical changes within such soils might be anticipated, not only during reclamation processes but later, when the soil would be under cultivation.

11. The many difficulties which have been encountered in endeavours to bring these existing potential rice growing areas into productivity have given cause for concern and for certain reasons (described in the Annual Report of this Section for 1947) as well as for reasons which will be amplified later, rice did not grow where it had been known to grow previously. During the dry seasons, when the soils were not in cultivation, evaporation processes favoured the movement upwards of dissolved salts already present in ground-water solution and a white efflorescence of harmful salts—notably the less common hydrated ferrous sulphate, $\text{FeSO}_4/4\text{H}_2\text{O}$ —appeared at the surface of the soil.

12. It must be here emphasised that conditions of water-logging existed in the grass-sedge, Alluvial swamps behind the river's flood plain long before reclamation processes had ever been contemplated and evidence of the excessive moisture conditions which prevailed can still be found in the typical horizons of peaty humus which have formed in recent time and which overlie the soils in these areas. By virtue of the dominating influence of excessive moisture the alluvial soils have become Marsh Soils.

13. The systems of drainage embodied in the original reclamation schemes did partially help to ameliorate conditions of water-logging, but not nearly to the extent desirable. There were not sufficient drains and those which did exist were not competent to adequately remove—

- (i) the excess rain water ;
- (ii) the excess surface drainage water and the seepage water from the catchment areas ;
- (iii) by leaching—the harmful salts which had formed under the anaerobic conditions prevailing and which had entered ground-water solution as a direct result of the natural processes which are known to occur in badly aerated and in water-logged soils.

14. The reasons why rice has not yet been successfully cultivated include—

- (i) failure to provide the drainage factors described above;
- (ii) instances of excessive flooding;
- (iii) the contributory factors of excessive weed growth against which young rice (both grown from broadcast seed and transplanted from nurseries) could not compete.

15. In the Annual Report (1947) this section of the Department made an appreciation of the major causes of the infertility of the soils and suggested certain lines of approach from which it was hoped to bring about improvements within the framework of existing schemes. It was considered that the problems should be treated in three phases:

- (i) The removal—by leaching—of the extremely acid ground-water and the dissolved salts contained in the water.
- (ii) The replacement—by speedy irrigation and by direct rainfall—of the acid ground-water by healthy ground-water.
- (iii) The maintenance—if possible—of the ground-water in a healthy state.

16. It was hoped to achieve these conditions by introducing more efficient drainage systems designed for the following purposes:—

- (i) To make drainage more rapid and irrigation more rapid.
- (ii) To ensure the percolation downwards, through the root range of growing plants, of oxygen-charged water.
- (iii) To prevent, if possible, harmful salts accumulating within the root zone of growing plants.
- (iv) To allow the lateral movement of excessive ground-water and surface water into the drainage channels.

17. When a healthy water regime had been established the next stage in reclamation required that the low plant-nutrient status of the soils be improved by—

- (i) first ameliorating soil acidity by the use of lime;
- (ii) building up soil fertility by the use of composts and fertilizers.

18. In accordance with the programme of work this year, modified and new systems of drainage were introduced in several places, including the Rokupr Rice Station polder, where a sub-soil system of brushwood drainage was also installed.

19. Although no spectacular results were expected or achieved, from the results of observations this year there are distinct indications of improvement on 1947 conditions, as judged by the survival and the growth of rice transplanted as seedlings in many test plots covering wide and representative areas.

20. Earlier in the year the Rokupr polder had been altered and a small polder, consisting of four Blocks, each surrounded by a drain 3ft. 6in. in depth had been constructed. Tidal river water could be admitted to these Blocks (or excluded from them) by opening or closing three sluice gates contained in one of the four perimeter bunds. The remainder of the original polder had been modified simply by gapping one of its perimeter bunds in appropriate places and constructing new waterways designed to allow the unrestricted and speedy irrigation by tidal river water and speedy drainage of the land in receding tides. In fact, with the exception of the newly created four Block polder, the conditions which now exist at Rokupr are essentially the same as they were before empoldering took place in 1944.

21. The success of reverting to the utilization of natural and unrestricted irrigation by tidal river water has been astonishing. Apart from some "patchy" growth in certain Blocks, the rice has this year tillered well and grown strongly and evenly. (In 1947 the majority of these Blocks were incapable of supporting any rice). In places where growth was patchy it was observed that the leaves of the rice plants in most cases were discoloured in various shades of purple. It is considered that this "purpling" may be ascribed to a temporary state of phosphate unavailability. Examination of past records of yield data of the Blocks on which "purpling" was manifested showed that a marked variation in productivity had always existed. It is doubtful that such variations could be properly explained by ascribing them to varietal differences in rices planted. On the other hand, from 1944 when the Rokupr farm was empoldered, until 1948 the ground-water within the polder became increasingly acid (pH 3), by virtue of the water-logging and reducing conditions which had prevailed. With this acidity became associated the presence of toxic concentrations of sulphates of iron and aluminium and both of these metals certainly appear to become more available with increasing acidity. In the dry season, when efflorescences of these salts appeared at the soil surface, it was found that traces of phosphate were also included in the efflorescences, possibly in the form of insoluble basic phosphates of iron and aluminium. In these circumstances a reduction in the amount of soil phosphate available to a growing crop might be anticipated. The role of phosphates in relation to the growth of rice in alluvial soils has yet to be investigated in detail but it does seem likely that until processes by which the pH of the soil is increased, e.g. by liming, and possibly associated with this, the addition of humus, no replacement of the combined phosphate may take place.

22. The new four-Block polder which exists within the modified framework of the old, has already been described. On the whole, it has produced promising results. These Blocks were not irrigated until 22nd July. Until this date, observations were made to see if the weight of rain water falling directly upon the Blocks would prove sufficient to cause effective leaching, downwards through the soil, of harmful salts in solution. As was anticipated, it soon became apparent that although leaching was taking place the process was far too slow and laborious when compared with the speed

washing of the topsoil and the leaching obtained in Blocks subjected to the natural conditions of free access and exit of tidal waters. It was therefore decided to abandon the method employed up to this date of opening the three sluices at each receding tide for the purpose of draining the polder and instead, to maintain the sluice gates permanently open. The sluices were accordingly opened on 22nd July and have remained open ever since. The deep drains surrounding each of the four Blocks prove very efficient waterways which allow speedy irrigation of the Blocks and speedy drainage of excess water away from the Blocks.

23. The operation of transplanting rice was delayed this year in order that all four Blocks could be well leached of their harmful salts. From the beginning of June, however, small test patches, each of a few rice seedlings, were transplanted at weekly intervals. By the end of July it appeared that the land was fit to support rice and transplanting took place during the first week in August.

One Block had been ridged in order to attempt to assess the value of this operation not only as a means to facilitating leaching and drainage but also as a precaution to ensure the roots of the rice plants would be kept above the level of acid ground-water, should it exist.

One Block had been provided with a system of sub-soil faggot drains which linked up with the main inter-block drainage system, the base of the faggot drains was at the same depth (3ft. 6in.) as the surrounding drainage channels. This system of drainage was most effective in ensuring the downward movement of water through the soil.

The remaining two Blocks of the polder, beyond the customary cultivation of the soil at the beginning of the rains, received no treatment and transplantation took place on the flat. On these two Blocks, the rice grew strongly and tillered well, but lacked uniformity. On the Block which contained the sub-soil drains, rice grew fairly strongly and quite uniformly except above the lines of the drains where there was no growth at all. On the Block containing ridges, approximately three months elapsed before the rice seedlings began to show any signs of growth at all. (It must be stated, however that in the cases of these two latter Blocks, no rice whatsoever grew on them in 1947).

Towards the end of the year a mixture of eight or more weeds and grasses made their appearance amongst the rice plants in all four Blocks and in the furrows of the ridged Block. Amongst the most common of the weeds may be listed *Fiurena umbellata*, *Paspalum scrobiculatum* and *Eleocharis plantagmea*. The mere presence of weeds was a heartening sign and a contrast to the reddish-brown ferruginous scum which appeared at the surface of the soil at this time the previous year.

24. At Luti and Rosino where land behind the flood plain of the Great Scarcies River had been empoldered in 1944, modifications, designed to achieve speedier irrigation and speedier drainage, had been made earlier this year. Subsoil systems of brushwood drainage had been introduced in one Block at each place. At Rosino, one Block had been ridged prior to transplanting rice. Both these areas are irrigated from the Great Scarcies River by the normal inundations of tidal water carried to and from the land in constructed waterways and drainage channels.

25. Test plots of rice were transplanted over representative areas of each polder in August, *i.e.*—late—in order that leaching of harmful salts could first be achieved as far as possible. At Luti the Africans of their own initiative actually used several blocks as rice nurseries. In all they cultivated over 60 acres for this purpose.

The test plots of maincrop rice at Luti were on the whole successful. At Rosino however, although growth was better than in 1947, it was nevertheless most disappointing in many parts of the polder. The groundwater in this area is still very acid and the soil has not yet been sufficiently leached of harmful salts. Where the soil had been ridged the rice fared very badly, indeed it appeared to show more signs of growth where it had been transplanted in the furrows than on the ridges where it was expected to do better. The block where a brushwood system of sub-soil drainage had been introduced supported only spindly, etiolated rice.

26. In both areas it is still apparent that the speed of irrigation and the speed of drainage have not yet reached the desired standards with the result that leaching harmful salts is still a laborious process and soil aeration has not yet become efficient. Even when these standards are acquired the task of building up soil fertility will still require to be faced.

27. It has become abundantly clear this year that the whole area within the Luti polder and the Rosino polder cannot be irrigated—at least under existing conditions—by the tidal inundations of fresh water carried by the Great Scarcies River. The utilization of river water when fresh, for irrigation purposes is convenient but it does appear to impose a limit on the extent to which irrigation-agriculture can be successfully practised on land behind a river's flood plain. Thus, at Luti and Rosino there are large portions of these areas which are outside the range of tidal inundations and although they are now drained (though not yet sufficiently aerated), it is doubtful if they can ever be irrigated naturally. The possibilities of utilizing water conserved in constructed reservoirs to provide a supplement to the fresh water of tidal rivers may be worth considering in relation to similar irrigation problems of the future.

28. *Saline Swamps.*—At Wellington, on a reclaimed deltaic alluvial soil on the coast of the Colony Peninsula, rice must be grown as a rain-fed crop. Efforts to grow rice in this polder however, have met with little success in the past and during each dry season a white or creamy-white efflorescence of sulphates of iron and aluminum together with sodium chloride appeared on the soil surface over many parts of this area.

29. There are within the polder over 60 acres of land and for this area only a single sluice gate (opened at every low tide) has been expected to remove surplus water. Unfortunately no additional sluice gate was permitted to be constructed during 1948 but existing open drains were widened and deepened and additional open drains were constructed to link up with those already present.

30. All operations at Wellington in 1948 were directed to;

- (i) removing, by leaching, the salts of iron and sodium;
- (ii) cultivating the land to be cropped, early, in order to aerate it;
- (iii) allowing approximately three months rainfall to achieve (i) above;
- (iv) transplanting the rice late—in August—in order to obtain maximum benefit from (i), (ii) and (iii).

With additional drains to supplement those already existing, it was anticipated that not only would drainage be made more effective but that toxic ground-water would be less likely to exist within the root range of growing plants. Ridging the soil was introduced on a small scale to assist, as an additional precaution, in maintaining the roots of the rice plants above ground-water level. Applications of burnt and crushed oyster shells (40 per cent CaO), at the equivalent rate of ten tons per acre CaO were made in small test plots as a means of ameliorating soil acidity.

31. Towards the end of the 1948 growing season most promising results had been achieved. The local African community utilized over fourteen acres of the land and the vigorous growth of their rice bespoke a good harvest. In those parts where rice had continually failed to grow year after year it survived and reached maturity in most test plots this year. Nevertheless, it has been clearly demonstrated this year that one sluice is inadequate to effectively drain the Wellington polder during the short time available between receding and incoming tides. The desired extent of leaching was not effected and surplus rain water, seepage and surface drainage water (from the catchment area in the Colony hills behind the polder) and the leachates from the soil could not be completely drained away. Thus an essential part of the plan—*i.e.* the speed of drainage—did not reach maximum efficiency.

32. Some visual evidence indicated that during the earlier part of the growing season ridging may be of merit in facilitating drainage and in preventing the accumulation of stationary surface water. On the other hand, as the rainy season advances and the intensity of rainfall decreases, the hours of sunshine daily increase, and it does seem that a ridged soil tends to dry out more rapidly than an identical soil which is not ridged. In the event, such was the experience at Wellington and was not foreseen at the time when transplanting rice was purposely delayed until August, for reasons already explained.

33. The application of burnt and crushed oyster shell at rates equivalent to 10 tons of CaO per acre produced a marked response in the growth and development of rice growing on all treated test plots. The beneficial effects of the "lime" must be largely attributed to the temporary neutralization of soil acidity but it is possible that in this soil the calcium may be utilised as a plant nutrient. At any rate, by raising the pH of the soil to neutrality the growth of rice became more vigorous and contrasted with the etiolated plants in untreated plots. Although pH values fell as the growing season advanced, the rice growing on plots which had received "lime" maintained their superiority over the rice growing in untreated soil. It would appear that a liming programme will inevitably play an essential part in the productivity of similar deltaic alluvial soils.

34. Facilities have been made to erect a second sluice gate at Wellington in 1949 in the most suitable place, to be determined by the results of a topographical survey. When this construction is completed the problems of leaching, of drainage and of establishing a healthy ground-water regime and of building up soil fertility, will be greatly facilitated.

35. The problems associated with irrigation-agriculture *e.g.*, as at Luti and Rosino on the Great Scarcies river, are complex and much fundamental work is most desirable. Continued engineering research on irrigation-drainage relationships will be necessary in order to ascertain the most efficient methods which can be successfully applied to the reclamation of Alluvial and Marsh Soils. Agricultural Research requires to be continued along two lines—technical and practical. The full development of areas which can be naturally irrigated for rice cultivation, requires no emphasis and attention must be directed to increasing their productivity by methods which include better cultivation, building up soil fertility and utilizing carefully selected rice varieties. In those areas which cannot be conveniently irrigated by tidal inundations of fresh river water, land utilization is a matter for investigation: attempts should be made to cultivate such crops as upland rice, cassava, sweet potato, etc., fibre plants, bananas and possibly oil-palms are worthy of trial. In the event, whether the land can be irrigated or not and whether the land is subsequently cropped later in the season or not, it is recommended that it should be cultivated as extensively as possible, for the following reasons:

- (i) to facilitate soil aeration;

- (ii) to increase the efficiency of soil aeration in light of the better conditions of drainage now being imposed;
- (iii) to reduce, and gradually eliminate the existing swards of useless grass and hydrophytic plants and thereby prevent them from competing for dominance with economic crops at a later date.

36. Much useful knowledge could be gained if botanical studies were made on the composition of the vegetation, especially in relation to the replacement of hydrophytic plants by other plants which are known to be associated with freely drained soils. Such studies would be necessarily confined to those areas which cannot be irrigated under existing conditions; but they could later be extended to include similar studies appropriate to the conditions which prevail on the river's flood plains where the land is naturally influenced by tidal inundations.

37. Technical research requires that investigations be made into soil-water relationships: the permeability of the soil and subsoil in relation to the leaching of the root zone; the occurrence and the implications of base-exchange in irrigated soils both during the dry season and during the rainy season and the nature of the irrigation water and its seasonal variations. This latter point of importance if a correct differentiation is to be made between:

- (i) harmful salts which enter ground-water solution as a result of dominating influences imposed on a soil—*e.g.* excessive moisture or water logging;
- (ii) harmful salts which can enter ground-water solution as a result of the nature of the dissolved salts contained in the irrigation water.

Many of the problems set out above are being investigated at present but little reliance can be placed on results which have been so far obtained on account of the difficulties involved in obtaining not only sampling techniques but acceptable and rapid methods of soil and water analysis.

38. There are indications that certain single factor physical constants of alluvial soils may with advantage be determined, *e.g.* sticky-point, *i.e.* the moisture constant at which the attractive power of the soil for water is just satisfied. It has been asserted that this factor is a measure of the maximum imbibitional capacity of the soil colloidal material for water and that there are grounds for the assumption that a sticky-point value represents:

- (i) water held in the interstices of the soil and
- (ii) water held by the colloidal material, *i.e.* by the organic matter and inorganic colloidal material associated mainly with the clay fraction.

From the results of determinations or of the sticky-point values of alluvial soils in the Scarcies area and elsewhere it has been found that there appears to be a close relationship between sticky-point and loss on ignition. The ratio sticky-point: loss on ignition, in a general way, increases from about 2.0 in the alluvial soils of flood plains to 4.11 in the Marsh soils (grass-sedge) behind the flood plains.

39. Attempts were made to find out if any relationship existed between pH values, total exchangeable bases and thiocyanate colour in alluvial soils. It was found, in very general terms, that the higher the pH value, the higher the percentage of exchangeable bases and the less depth of thiocyanate colouration. The thiocyanate test depends on the neutral salt action and it might be expected of acid alluvial soils that there is a rapid replacement of hydrogen ions in the reactive surface of the soil particle by the cations of the neutral salt. Iron and aluminium present in the soil come rapidly into solution, no doubt on account of the increase in the hydrogen concentration of the system. Even when there is considerable organic matter present in these

soils ferric thiocyanate develops and deepens immediately the potassium thiocyanate comes into contact with these soils. When weighed quantities of these soils are shaken with a known volume of alcoholic potassium thiocyanate for a set time and, after filtering, a known volume of the filtrate is boiled and titrated with deci-normal caustic soda, using phenolphthalein as indicator it is found that soils with higher pH values have less titrable acidity. In extremely acid soils, *i.e.* pH values less than 4, hydroxides of aluminium are precipitated during the titrations. It was not possible to determine precisely at what pH precipitation began.

Native Agricultural Practices—Bush Burning (i)

40. The form of subsistence farming characteristic of the African farmer in the uplands of Sierra Leone is that of "Shifting cultivation," the practice by which, in the words of the late Sir A. Daniel Hall, "the cultivator clears a patch in the bush and crops it for perhaps a period of three years. He then abandons it for another clearing and does not recur to the same land until a varying number of years have elapsed, during which the land accumulates fertility again and the weeds of cultivation die out."

41. This form of agriculture has met with severe criticism from many quarters. One authority discussing Sierra Leone has stated that Shifting cultivation is a "pernicious system which has caused the degradation of the soil in the upland regions of certain parts of the country." This same authority has asserted that degradation, which is progressing rapidly under this system of agriculture and soil erosion, which is now severe, can only be arrested by excluding shifting cultivation from the hill slopes in order to relieve pressure on the uplands. Lord Hailey, on the other hand would appear to regard shifting cultivation as a form of agriculture not without some merit for he has stated that "it may be less a device of barbarism than a concession to the character of a soil which needs long periods for recovery and regeneration".

42. Any reform of shifting cultivation, if reform is necessary, may involve the obligation to persuade the native farmer to modify his methods of farming and perhaps his farming customs as well. It would therefore appear most necessary to first understand the underlying principles of traditional African farming practices before attempting to impose new and alternative (and possibly not-well tried) methods on a conservative people.

43. The field study to be described was made this year with the intention of obtaining information on some aspects of shifting cultivation, especially with regard to the merits (or demerits) of burning cleared bush prior to cropping the land by cultivating upland rice.

44. The site selected for the experiment was approximately two miles away from the Department's Headquarters at Njala. The soil here is a deep, acid (pH-5.2), reddish-brown gravel loan (Lateritic) derived from sedimentary rocks, and contains much purple, cemented, ferruginous sandstone. The vegetation—secondary bush—was known to be no more than 7 years old and was composed mainly of *Morinda geminifolia*, *Ochthocosmos Africanus*, *Albizia zygia* and *Phyllanthus discoides* while grasses and ground creepers were present in small amounts.

45. The experimental layout comprised three 1-acre Blocks separated by lanes some 2 yds. wide. Block treatments were as detailed hereunder:

- | | |
|----------------------|---|
| Block 1, Treatment 1 | .. brushing and burning the secondary bush, in situ, and incorporating the resulting ash in the soil. |
| Block 2, Treatment 2 | .. brushing the bush, burning the vegetation elsewhere and returning and incorporating the resulting ash in the soil. |

Block 3, Treatment 3 .. brushing the bush and completely removing the vegetation elsewhere.

Bush burning was carried out on 19th April, and the wood ash incorporated in the soil the following day. Bologhuti rice was sown on 25th May using the technique of the African farmer, *i.e.* broadcasting, at a seed rate of 60 lb per acre and the seed covered in the usual way by lightly turning over the surface soil with native hoes.

46. The data produced below reflect the effects of the different treatments on the yield of rice (padi):

		<i>Block 1</i>	<i>Block 2</i>	<i>Block 3</i>
Date of broadcasting rice	.. ..	25th May	25th May	25th May
Date of rice flowering	.. ..	28th Aug.	23rd Aug.	23rd Aug.
Date of rice harvest	.. ..	15th Oct.	21st Oct.	25th Oct.
Yield (lb. Padi per acre)	.. ..	886	327	199
Ratio (Grain: Straw)	.. ..	0.43	0.41	0.29

That marked variation in yields of rice have resulted from the effects of the different treatments, there can be no doubt, but additional aspects of these treatments require comment.

47. By treatment 1 it was found that:

- (i) the mineral constituents of the wood ash were retained on the site of the burn;
- (ii) the actual process of burning appeared in no way to either destroy the humic layer (1 inch or more in depth), or to effect the clay complex in any way for the heat of the burn seemed to be largely superficial;
- (iii) by burning, vegetable matter, composed largely of leaf fall, and probably of high carbon to nitrogen ratio and not yet metamorphosed to humus, was destroyed.

48. By treatments 2 and 3 the vegetable matter remained in situ, unburnt. It is possible in these circumstances that bacteria, which oxidise this organic matter, may require to compete with and deprive the rice crop of the soil's nitrogen, for their own activities will require a continuous source of available nitrogen.

49. By Treatments 1 and 2 wood ash was added to the soil and the effect of this material not only on the soil reaction but on the total exchangeable bases, was clearly profound. Results so far available on the composition of the wood ash resulting from the burn are as follows:—

		pH	12	
Total	.. ..	CaO	28.84	per cent
„	.. ..	K ₂ O	21.27	„
„	.. ..	P ₂ O ₅	2.84	„
Citric soluble	.. ..	P ₂ O ₅	0.92	„

Further data are at present being obtained on the precise composition of the wood ash (including estimations of the minor elements which it is considered, may be of great importance), by spectrographic analysis in the United Kingdom.

50. Under Treatment 1 the rice tillered better and produced more vigorous and uniform growth and taller plants than was the case under Treatments 2 and 3. Treatment 2 produced patchy, uneven growth and moderate tillering. Under Treatment 3 the rice appeared chlorotic, spindly and growth was very uneven.

51. Initially the extent of weed growth seemed to be greatest under Treatment 2 where the wood ash had been returned to the soil, but the growing rice competed successfully. Under Treatment 1 where burning had been carried out in situ, weed growth was least and remained least throughout the growing season of the rice crop. It is possible that the heat of the burn though superficial, may nevertheless be sufficient to reduce the number of viable indigenous weed seeds contained in the surface soil, or at least retard their germination. On the other hand, as the rice grew to maturity on Blocks 2 and 3 it became impossible to assess which of these Blocks contained most weeds.

52. Results of observations appeared to indicate that under the conditions of this experiment, rates of bush regeneration tended to follow the same trends as the development of weed growth. Thus, burning bush in situ (Treatment 1) temporarily retarded coppicing, presumably by virtue of the damage caused to the bark of the trees by a running fire. Returning ashes to the soil (Treatment 2) seemed to encourage more rapid coppicing than under the conditions of Treatment 3. By the time rice had been harvested from all Blocks however, the regeneration of the bush appeared identical in all cases and if differences did exist they could be of little significance when considered in relation to the years of bush fallow which are to follow.

53. Under Treatment 3 the disease *Piricularia oryzae* rapidly became evident on the young rice seedlings and remained throughout their growth and maturity.

54. Precautions against the depredations of squirrels, ground rats and monkeys and later, birds, were taken throughout the course of this experiment.

55. At the time of harvesting the rice the following additional data were obtained:—

FIGURES BASED ON AIR-DRY SOIL

				Moisture	pH	Total Exchangeable Base. mgm.E. per 100 grams	Total Nitrogen
Treatment 1	..	..	..	2.878	5.9	11.70	2.88
„ 2	..	..	..	3.360	5.4	9.75	3.36
„ 3	..	..	..	3.384	5.2	8.78	3.38

Native Agricultural Practices—with Modifications (ii)

56. It has been asserted in connection with leguminous plants that their nodules excrete simple nitrogen compounds built up from atmospheric nitrogen and that these compounds or their immediate decomposition products are available to non-leguminous plants sharing the same soil. It has also been stated that there is evidence that leguminous plants can dissolve some of the less soluble phosphates in the soil and make them available to other crops incapable of attacking them directly. Obviously therefore such effects, —as well as the possible additional effects caused by leguminous crops sending their roots to depths well beyond the range of non-leguminous crops in search of water and plant nutrients—if they can be shown to exist, may be of profound importance in modifying the fertility of soils in the humid tropics.

57. If such a legume can be cultivated by methods of intercropping with an economic cereal crop—or any convenient subsistence crop—and at the time of harvesting the latter, it is sufficiently established to form a canopy over the whole of the cultivated area, than a step forward would appear to have been made in the search for a method whereby the mechanical losses and

losses due to lixiviation, may be substantially reduced. Whether such a legume can be used as a fallow "crop" to regenerate soil structure and soil fertility over a period of years and whether, at the end of this time it will prove as efficient for this purpose as the traditional system of a bush fallow for the same period, is a matter with which this investigation will be later concerned.

58. During the present year (1948) however the main problems were to see if—

- (i) it is possible to establish leguminous crops through an economic cereal crop;
- (ii) leguminous crops may be of benefit to the growing of a cereal crop;
- (iii) certain legumes are capable of forming sufficient soil cover by the time the cereal is harvested, and are of assistance in preventing mechanical losses due to lixiviation.

59. The experiment to be described was made at Njala. The soil here is a very deep, acid, reddish-brown ironstone-gravel. A record of the seasonal variation in temperature, humidity and rainfall is reproduced below:—

60. A rectangular block, one acre in area, supporting bush known to be at least eighteen years old, was selected as the site for the experiment. Traces were cut round the perimeter of the site and all trees and bushes in the block were felled and burnt. The ashes resulting from the burn were uniformly distributed and incorporated in the soil. With the exception of the great care exercised in spreading and incorporating the wood ash all other preparatory operations followed the same pattern as the traditional methods practised by the Mende farmer in Sierra Leone.

61. The block was divided into four plots each of $\frac{1}{4}$ acre. In Plot 1 Kono groundnuts were dibbled in rows three feet apart and with intervals of two feet between seeds, on 12th May. On 19th May, Bologhuti rice was dibbled by hand throughout all four plots and parallel to the largest side of the original rectangle. The rows were nine inches apart and the dibbled grains spaced at intervals of nine inches. Germination was rapid and growth vigorous and uniform throughout all plots.

62. After weeding all plots by hand on 1st July, *Pueraria phaseoloides* was broadcast throughout Plot 1 at a rate equivalent to 12 lb. per acre and *Tephrosia candida* was broadcast throughout Plot 2 at a rate equivalent to 8 lb per acre. On Plot 4 rice was allowed to grow without a legume sharing the same soil.

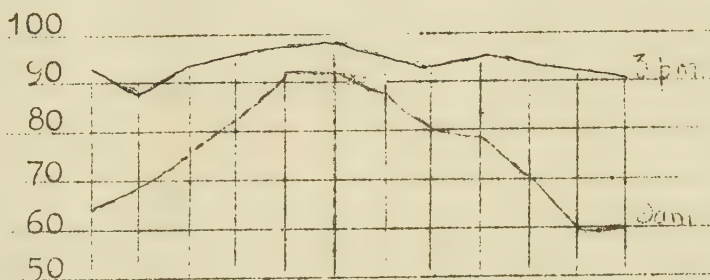
It may be here stated that dibbling rice seed is a departure from the usual native method of broadcasting. Although this method may be criticised on the grounds of the labour involved it has the undoubted advantages nevertheless of securing a completely uniform seed bed and it also ensures that the grain is completely covered and not exposed to the depredations of birds, etc. as is so frequently the case when broadcasting is followed by shallow top-soil hoeing to cover the seed.

63. On 30th August the Kono groundnuts were harvested. 40 to 41 lb. of undecorticated material was obtained. Harvesting was in all respects satisfactory and the material was found to be of good quality. The results of the examination of the data produced are given below:—

Moisture in air-dried, shelled groundnuts grown alone (Njala Block 49)	7.25	Per cent
Moisture in air-dried, shelled groundnuts grown under cover of rice (Plot 3)	13.33	„
Ether extract in dry matter of shelled groundnuts (Block 49)	47.3	„
Ether extract in dry matter of shelled groundnuts (Plot 3)	50.3	„

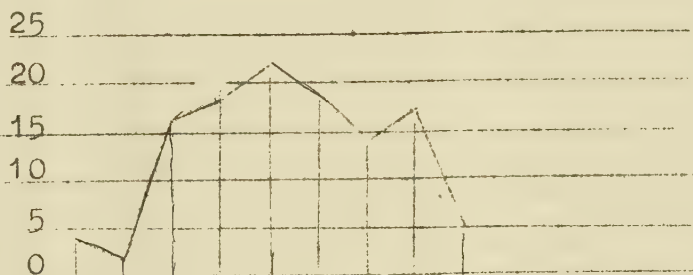
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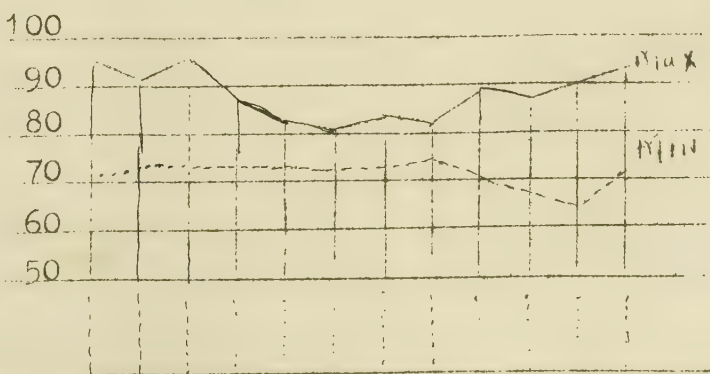


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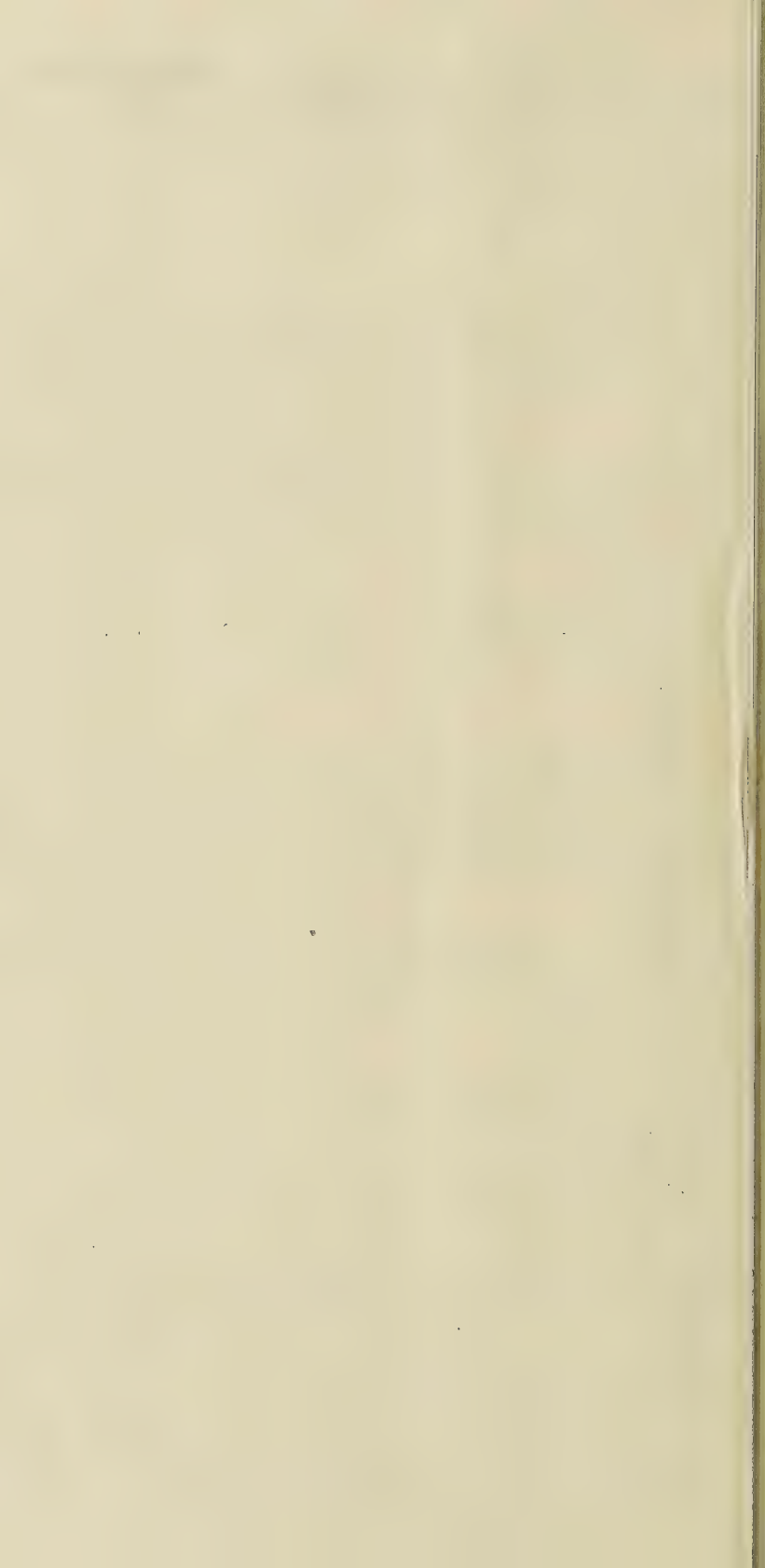
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In the event, having regard to the spacing of the groundnuts and to the fact that this crop was expected to reach maturity under cover of vigorously growing rice, the yield must still be regarded as most disappointing.

64. The rice flowered uniformly throughout all plots on 6th August and harvesting, which began on 12th October, was completed the following day. Yields obtained from individual plots are shewn below:—

Plot 1	Rice with <i>Pueraria Phaseoloides</i>	..	407 lb. padi—	1,628 lb. padi per acre.
Plot 2	Rice with <i>Tephrosia Candida</i>	..	447 lb. padi—	1,788 lb. padi per acre.
Plot 3	Rice with Kono Groundnuts	..	365½ lb. padi—	1,462 lb. padi per acre.
Plot 4	Rice alone	.. ..	344 lb. padi—	1,376 lb. padi per acre.

These yield data contrast greatly, and most favourably with that obtained from the previous experiment where the duration of the bush fallow was only seven years. It would appear too, that the legumes may be of benefit to the cereal crop; at any rate their presence does not seem to have been detrimental to the crop sharing the same soil. By the time the rice was harvested a luxuriant canopy of *Pueraria phaseoloides* covered Plot 1 and in Plot 2 *Tephrosia candida* had become firmly established. The actual process of harvesting the rice thus required to be carried out with great care.

65. On Plots 1 and 3 weed growth was negligible. Plot 2 contained a fair proportion, and Plot 4, where no legume had been cultivated weed infestation was greatest by far and *Solanum torvum* appeared in great profusion.

66. Rates of coppicing appeared to be the same in all plots and the thick canopy of *Pueraria* seemed in no way to adversely affect the regeneration of the bush on Plot 1.

67. A remarkable feature in the case of Plot 1 was that even in early December, i.e. two months after the rice harvest, the top-soil was still markedly alkaline and the addition of dilute acid to random soil samples would produce effervescences. After the experiment, that is to say, after the rice harvest, Plot 2 topsoil was just on the acid side of neutrality (pH value 6.8). Plot 3 topsoil was slightly more acid (pH value 6.4) and Plot 4 top-soil where rice had grown alone the pH value had fallen to 5.6. The percentage total exchangeable bases followed the same trend as pH values in each plot and it is suggested that these values may be used (admittedly with some reserve) to indicate that losses due to lixiviation and mechanical losses as well are reduced when some form of ground cover grows up sharing the same soil as a subsistence crop and can immediately replace the latter when it has reached maturity.

Native Agricultural Practices—with Modifications (iii).

68. The value of resting a soil for a long period under bush fallow and the desirable physical effects (pH) and chemical effects (exchangeable ions) brought about by the addition of wood ash to the top-soil have been described. It does seem fairly well established that deeply rooted trees and plants do tap the available plant nutrients contained in the sub-soil, and restore them to the surface soil through the vegetation.

69. When the experiment to be described was laid down the above remarks were largely based on presumptive evidence. Nevertheless at the time it was considered desirable to make an attempt to evolve a method of establishing bush rapidly, and for two reasons, namely:—

- (i) to utilize the experience gained, if practicable, in the reafforestation of degraded uplands at a subsequent date;

- (ii) to study the possibilities of hastening regeneration processes under bush fallow by cultivating specially selected forest seedlings but at the same time not unduly interfering with the normal growth of coppiced trees on and in cultivation.

70. The site selected for this experiment (1-acre Block) is adjacent to the site of the foregoing experiment. The bush, at least 18 years old was felled and burnt in the usual way on 17th April and the ashes resulting from the burn were spread as evenly as possible and incorporated in the soil the following day.

71. During the first few days of June shallow pits were dug at intervals 8' by 8' throughout the block in readiness for the forestry seedlings which were to be transplanted at a later date. On 7th June Bologhuti rice at a seed rate of 60 lb., was broadcast over the 1 acre block.

Transplanting the forest seedlings began on 21st July and the varieties selected conformed, as far as is known to the following qualifications:

- (i) quick growing;
- (ii) able to produce adequate shade;
- (iii) believed to be of value in soil regeneration;
- (iv) of some economic value to the African.

They were *Terminalia ivorensis*, *Tarriettia utilis*, *Sarcocephalus diderichii* and *Gmelina arborea* and one quarter of an acre was allotted to each species.

72. Fertilizers were used to try to establish the seedlings and each $\frac{1}{4}$ acre containing 144 seedlings was subdivided into 8 plots each containing 18 seedlings and which received the following treatments at the rate of 2 ozs. per seedling:—

n	p	k	npk	(n-S. of Ammonia
o	np	nk	pk	(p-Superphosphate
				(k-Muriate of Potash

73. When transplanting was completed the seedlings had perforce to be left to their own devices for by this time the rice was growing strongly and it was considered desirable not to trespass amongst the crop in order to examine individual seedlings. Nevertheless it could be clearly seen from the footpath round the perimeter of the block that *Gmelina arborea* had become established very quickly and there appeared to be few misses. Examinations of the other species where they occurred on the remainder of the perimeter showed that though they were alive, growth was not vigorous and as the season advanced many of these perimeter seedlings died. It was later shown that where deaths occurred the roots of the forest seedlings had without exception suffered the severe depredations of white ants.

On 28th October the rice was harvested and yielded 1,301 lb padi. It may be here noted how closely this yield is allied to that of 344 lb padi from $\frac{1}{4}$ acre (1,376 lb acre) obtained in the experiment previously described where the same kind of land had been under the same bush fallow for the same length of time.

74. After the rice harvest it was possible to examine all individual seedlings of each tree variety planted. The data obtained, which were most disappointing, are shown below:

Variety	Trees planted	Survivals	Per cent Survival
<i>Terminalia ivorensis</i>	.. 144	5	3
<i>Sarcocephalus diderichii</i>	.. 144	8	8
<i>Tarriettia utilis</i> ..	.. 144	67	46
<i>Gmelina arborea</i> ..	.. 144	116	80

Survivals of trees planted, in relation to the fertilizer applied are given for "Tarrietia" and "Gmelina":—

n	14	..	..	o	15	n	13	o	18
p	15	..	..	np	9	p	18	np	9
k	4	..	..	nk	2	k	17	nk	15
npk	6	..	..	pk	2	npk	12	pk	14

75. There can be no doubt that during the course of this experiment, certain mistakes were made. The first, and probably the most important, was in the timing of transplanting. As has no doubt been seen earlier, July rainfall was greatest and it was hardly possible during this month to obtain a single day sufficiently free from rain to allow the placement of small quantities of fertilizers. Transplanting was therefore delayed and when the operation eventually took place the climatic factor as well as the lateness in season militated against the successful establishment of the seedlings. Under the conditions of heavy rainfall which occur at this time of the year the lixiviation of fertilizer constituents must inevitably be very great and prior thought should have been given to methods designed to hold the fertilizers in the soil surrounding the roots of the young seedlings, especially as none of the fertilizers used were "slow-acting." A basal dressing of some form of compost, possibly fortified with slow-acting fertilizers might have been more successful but even so, such a compost would also have required treatment with insecticide of some description as a precaution against its rapid metamorphosis at the hands of ants, etc.

76. From the results of the work this year it would appear that the only seedlings readily established were those of *Gmelina arborea*, and a repetition of this work, having regard to the mistakes made this year, will be necessary in 1949.

The Establishment of Pueraria Phaseoloides and of Tephrosia Candida.

77. In the studies already described on the effects of burning bush cleared for cultivations, it has been shown that there are good grounds for believing that traditional native agricultural practices may be explained in terms of the circulation of plant nutrients from the soil to the plant and back again. Deeply rooted coppiced trees and shrubs reach down to the depths where weathering is in progress and fresh ions are brought up in solution, to be added to the stocks of nutrient elements held in the vegetation and the topsoil.

78. As it is not known whether deeply rooted leguminous crops have the same effects in Sierra Leone and are able to obtain nutrients, and water, from the deeper soil horizons it was considered desirable to establish, by cultivations, two legumes—*Pueraria phaseoloides* and *Tephrosia candida* with a view to studying their effects as a cover crop on—

- (i) the restoration of soil fertility and soil structure, destroyed by many years of continuous cropping and, in the case of "Pueraria" alone;
- (ii) the prevention, or at least control, of soil erosion;
- (iii) to assess its value as a protein-rich fodder crop.

79. As has been stated elsewhere, the soil at Njala is a deep, acid reddish-brown gravel loam (Lateritic). It is of low nutrient status. It, is at least doubtful that resting a tropical soil of this nature under a leguminous fallow will, in itself, restore fertility and it was therefore decided to endeavour to establish a good stand of "Pueraria" and of "Tephrosia" by cultivating these legumes with the assistance of farm yard manure and fertilizers.

80. During the first week of June, *i.e.* one month after the beginning of the rains, two one-acre blocks were ploughed by oxen to a depth of not more than 6 inches and a dressing of manures was applied to each block as follows:—

5 tons farmyard manure
2 cwt. superphosphate
4 cwt. sulphate of potash

The manure and fertilizers were incorporated in the top-soil by harrows and "Pueraria" was broadcast on one block at a seed rate of 12 lb. per acre and "Tephrosia" was broadcast on the other block at a seed rate of 6 lb. per acre. At the time of broadcasting, moderately fine seed beds, free from weeds, had been obtained. The seeds of the legumes were covered by light peg harrows but the soils were not consolidated by rolling.

81. Germination and growth of both legumes was very slow and weed-growth quickly entered competition, with the young, etiolated seedlings. The "Tephrosia" was particularly disappointing and it is doubtful if more than one-third of the seed sown had germinated. Carefully conducted hand-weedings took place early in July and again early in August in order to eliminate undesirable plants such as *Panicum laxum*, *Panicum purpurascens* and *Calopogonium mucunoides*.

82. In October a further 6 lb. of seed was broadcast and covered in the "Tephrosia" block. The germination of this seed was more rapid and the seedlings, early in December appeared sufficiently strong and well-established to withstand the dessication of the dry season to follow. No further hand weedings were undertaken.

83. By the beginning of October, *i.e.* four months after it had germinated the "Pueraria" had produced an abundant cover of dense foliage supported on long, trailing runners. At this stage it was cropped lightly by cutlasses at a height of no less than 6 inches from ground level. The leafy material and runners yielded on an air-dry basis 1,900 lb. of hay. The aftermath in December was at least as abundant as at the time of first-cutting and probably more so. This legume, now only in its sixth month after germination has become sufficiently strong and vigorous to withstand the dry season.

84. It is suggested that in the management of a leguminous sward such as "Pueraria" may be expected to provide in its first year the desiderata should be in the first place to establish a cover strong enough to withstand the dessication of the succeeding dry season, and not to endeavour to obtain a heavy yield of edible material. If it is possible to both establish the sward and to obtain a crop for hay, care should be taken to seek only a light harvest timed prudently in order to allow a strong aftermath to develop.

STUDIES ON THE APPLICATION OF FERTILIZERS TO ROOT AND CEREAL CROPS

(i) *A Fertilizer field experiment with Yams as the Test Crop.*

85. At Njala a 1-acre block supporting elephant grass was burned and the stubble, together with the ash resulting from the burn, was incorporated in the soil by ploughing, using oxen as draft animals. The experimental layout consisted of four blocks each containing eight plots and all blocks were ridged by hand at intervals of 5 feet between ridges. Two blocks received a basal dressing of compost at a rate equivalent to five tons per acre; the remaining two blocks received a basal dressing of compost equivalent to ten tons per acre. Each block contained an 8-treatment test using all combinations of N.P.K. fertilizers; sulphate of ammonia and superphosphate were used at rates equivalent to 1 cwt. per acre, and muriate of potash at a rate equivalent to 2 cwt. per acre.

86. The method of applying the compost and fertilizers was simple and well within the capacity of the African farmer to emulate. The compost was spread evenly at appropriate rates of application throughout the ridges and the fertilizers, in accordance with the several treatments were spread by hand over the compost. The ridges were then split, and on the new ridges the yams were planted, at two feet spacing, (with 3 feet between plots) the following day. Beyond the erection of stakes to train the vines, and two hand weeding during the growing season no cultivations were necessary and harvesting took place in mid-January.

A summary of the results of this experiment is shown below:—

<i>Mean Yields; cwt. per acre</i>			
<i>Compost</i>	<i>5 tons per acre</i>	<i>10 tons per acre</i>	<i>Mean</i>
N absent (*6.37)	59.4	53.9	56.6 (+4.50)
N present	59.6	55.9	57.7
Response to N (+9.01)	0.2	2.0	1.1 (*6.37)
P absent (*6.37)	56.1	51.3	53.6 (*4.50)
P present	63.1	58.5	60.7
Response to P (*9.01)	7.0	7.2	7.1 (*6.37)
K absent (*6.37)	59.4	57.0	58.1 (*4.50)
K present	59.7	52.9	56.2
Response to K (+9.01)	0.3	—4.1	—1.9 (*6.37)

* Indicates $\frac{+}{-}$

Mean Yield: 57.2 cwt. per acre

„ Error: 18.01 „ „ (31.5 per cent)

87. The results of this fertilizer trial indicate that although responses were obtained from the application of N and K, they were not sufficient to be significant and in the case of P too, where greater responses were obtained the measure of the response was below that required for significance.

(ii) *A Fertilizer field experiment with Sweet Potatoes as the Test Crop at Njala*

88. The layout for this experiment consisted of four blocks each containing five plots. The plot treatments were Nil, C, NKC, pC, and NKPC; where C=compost, N=sulphate of ammonia, K=muriate of potash, p and P=superphosphate. The compost used had been made during 1947 and in the course of its preparation—from vegetable matter, leaf fall, etc.—2 cwt. of sulphate of ammonia, 2 cwt. of muriate of potash and 2 tons of farm-yard manure had been added. N, K and p were applied to appropriate plots at rates equivalent to 2 cwt. per acre, P was applied at a rate equivalent to 4 cwt. per acre. The compost was applied at 4 tons per acre, *i.e.* 2 cwt. per plot, where given, and this weight of compost might be expected to contribute the same amount of potash as the equivalent rate of 2 cwt. muriate of potash per acre, applied directly. The nitrogen in the compost, determined by chemical analysis, amounted to 1.12 per cent. The cultivations, method of preparing the land and method of applying compost and fertilizers were substantially the same as described in the previous field experiment except that the spacing in this instance was at 1 foot intervals,

89. Both vines and potatoes were harvested in mid-December and yield data are shown below:—

VINES						
	<i>O</i>	<i>C</i>	<i>NKC</i>	<i>pC</i>	<i>NKPC</i>	<i>Total</i>
	115	252	414	294	520	1,599
	Correction 127,201.25 Mean 79.75 or 28.4,822 cwt. per acre.					
Blocks ..	..	..	3	10,426.55		
Treatments ..	..	..	4	24,039.00		
Error ..	..	..	12	2,730.20	227.517	*15.084 or 18.9 per cent
Total ..	..	..	19	37,195.75		+5.3,871 cwt. per acre

POTATOES						
	<i>O</i>	<i>C</i>	<i>NKC</i>	<i>pC</i>	<i>NKPC</i>	<i>Total</i>
	60	175	375	229	514	1,353
	Correction 91,530.45 Mean 67.65 or 24.1,607 cwt. per acre					
Blocks ..	..	..	3	3,138.55		
Treatments ..	..	..	4	31,341.30		
Error ..	..	..	12	3,200.70	260.72	*16.332 or 24.1 per cent
Total ..	..	..	19	37,680.55		*5.8,329 cwt. per acre

Area 1/40 acre

1 plot factor 0.357,143

4 plot factor 0.0892,857

YIELD: CWT. PER ACRE					
<i>O</i>	<i>C</i>	<i>NKC</i>	<i>pC</i>	<i>NKPC</i>	<i>Mean</i>
<i>Vines; cwt. per acre</i>					
10.3	22.5	37.0	26.2	46.4	28.5
(*2.69)					
<i>Potatoes; cwt. per acre</i>					
5.4	15.6	33.5	20.4	45.9	24.2
(*2.92)					

* Indicates $\pm$

90. It will be readily seen that the application of "fortified" compost has produced more than a twofold increase in the yields of both vines and sweet potatoes. The response of vines and potatoes to NKPC and to NKPC is most marked.

(iii) *A Fertilizer field experiment using Upland Rice as a Test Crop at Njala.*

91. The site selected for this experiment was a 1x acre block which had maintained a sward of "Pueraria" during the past seven years. This legume however, had been continuously cropped for fodder during this period and it is a moot point if it could, in these circumstances, be expected to contribute either to soil regeneration processes or act as a medium for building up soil fertility.

92. The layout of the experiment consisted of two blocks, each containing nine treatment plots. The treatments were as follows:—

P1, P2, K1, K2, P1K1, P1K2, P2K1, P2K2, Nil.

where P1=superphosphate applied at a rate equivalent to 2 cwt. per acre.

P2=superphosphate applied at a rate equivalent to 4 cwt. per acre.

K1=muriate of potash applied at a rate equivalent to 2 cwt. per acre.

K2=muriate of potash applied at a rate equivalent to 4 cwt. per acre.

Bologuti rice was broadcast at a seed rate of 60 lb. per acre immediately after fertilizers had been applied on 26th May. The rice was harvested on 18th October. The results of this experiment are shown below:—

PADI RICE—LB. PER PLOT

			—	p1	p2	Total
—	..	..	45	76	57	178
k1	..	..	60	76	68	204
k2	..	..	53	42	69	164
Total	..	..	158	194	194	546

Correction	..	..	16,562.00	Mean 30.3 or 4.875 cwt. per acre.
Blocks 1	..	..	555.556	
P 2	..	..	144.000	
K 2	..	..	137.333	
PK 4	..	..	348.667	
Error 8	..	..	512.444	64.056 *8.0035 or 26.4 per cent +1.2863 cwt. per acre
Total 17	..	..	1,698.000	

Area 1/18 acre

1 plot factor 0.160714

2 " 0.0803571

6 " 0.0267857

PADI RICE—CWT. PER ACRE

		p1	p2	Mean
		(*0.91)		
—	3.6	6.1	4.6	4.8
K1	4.8	6.1	5.5	5.5
				(*0.53)
K2	4.3	3.4	5.5	4.4
Mean	4.2	5.2	5.2	4.9

(*0.53)

* Indicates $\pm$

93. The results of this experiment, which are non-significant, do seem to imply however, that the higher rate of application of superphosphate has not been justified and, in the case of the higher potash application, a depression in yield has resulted. It is of interest to compare the extremely poor yields obtained in this fertilizer trial with the yields of upland rice—quoted earlier in this report—and obtained by following native agricultural practices.

(iv) *A Fertilizer field experiment with Swamp Rice at Newton.*

94. The experiment to be described was carried out at the Newton Agricultural Station on a light, sandy inland seasonal swamp soil which had been empoldered some years previously but had remained unproductive. A basal dressing of compost was applied over the experimental area, at a rate equivalent to 10 tons per acre—late—i.e. within 10 days of transplanting the rice. The layout consisted of three blocks each containing four treatment plots. The treatments were as follows: Nil, P, K, Pk. P and K were respectively superphosphate and muriate of potash and they were applied at rates equivalent to 2 cwt. per acre at the time of transplanting i.e. in July. The rice plants were spaced at 9" intervals, with three seedlings per stand. Harvesting took place during the first week of November.

Preliminaries to a future Soil Survey of Sierra Leone.

99. Work in connection with initiating a soil survey has necessarily to be treated—as yet—more in the nature of a hobby than as a planned study. The Government Geologist has assisted by providing the most accurate knowledge available on the geological sequence and lithology of the country and in the identification of rock specimens. Particular attention has been given to the chief soil-forming rocks, especially those of the coastal deposits—*i.e.* the sedimentary rocks of lacustrine, estuarine and deltaic origin, for it is upon these deposits that our largest rice-growing and potential rice-growing areas occur—*e.g.* Luti, Rosino and Rokupr which have been mentioned earlier in this report. Soil surveys have been made of all three places named. The coastal sediments rest on metamorphic rocks of the “Kasila” series which are composed essentially of crystalline gneisses and granulites with some schists and include pyroxene gneiss, garnetiferous hornblende gneiss, a felspathic gneisses and banded quartz magnetite rocks.

100. On the Kasila series in the Kambia and Port Loko areas there are large expanses of what may be described provisionally as Lophira-tall grass savanna, *i.e.* vegetation where trees do not form a really close canopy but are isolated, and grasses, *e.g.* *Andropogon tectorum*, *Andropogon gabonensis* and *Chasmopodium caudatum* provide a tall, thick, ground sward. The predominant trees include *Lophira alata*, *Parkia biglobosa* and *Pterocarpus erinaceas*. These almost unpopulated areas either remain uncultivated or are cultivated only to a very small extent and probably in consequence, little or no interest has been taken in the soils which usually have large chunks of fossil “Laterite” resting on the soil surface or at the top of a profile. When cross sections of these areas are prepared from contour maps it can be seen that Lophira-tall grass savanna occurs in regular topographical sequence on peneplains or benches which are usually well dissected.

101. It would seem that “laterite” at an earlier period had been formed as an illuvial horizon within the soil (by the precipitation of the oxides of iron in the zone in which the upper surface of the ground-water fluctuates), at a time when the ground-water was closer to the surface than it is now. Later, when this illuvial horizon had become sufficiently developed and impervious, and after the base level of the region had been lowered, the looser alluvial horizon of the soil became truncated by erosion (possibly facilitated by deforestation and cultivation), thus exposing the ironstone which can be found on the soil surface. Weathering processes which continued after the lowering of the base-level have given rise to Yellowish-red “Lateritic” loams, rich in discrete concretions and frequently overlain by a loamy lixivium, free from gravel.

ENTOMOLOGICAL SECTION

81. The Entomologist, Mr. F. A. Squire, returned from vacation leave on 18th February and was in charge for the rest of the year. He reported as follows:—

POPULATION STUDIES

1. “Population studies by means of a light trap were continued at Njala throughout the year. As in 1947, the dry season yielded mostly Orthoptera, Hemiptera and Coleoptera. Lepidoptera which increased with the rains up to July when, with the onset of the heavy rains, the incidence of nearly all insects declined sharply. Only a few pyralids, coreids and cercopids shewed a tendency to increase during this third quarter. The mathematical relationship between the number of species and number of individuals taken will be examined later.

TERMITES

2. The collection and study of termites was continued. Twenty-seven different species have so far been taken. Critical determinations of ten of these have been obtained through the Commonwealth Institute of Entomology. A remarkable fact worth recording is the large scale invasion of *Cubitermes termitaria* by *Eutermes* sp. in the north of Sierra Leone where nearly every *Cubitermes* nest has recently been either wholly or partly occupied. Many *Macrotermes* nests have likewise been taken over. In addition a good many typical *Eutermes termitaria* were observed. Curiously enough *Eutermes* also occurs as an inquiline in the nests of *Cubitermes* at Newton near Freetown as well as in its own *termitaria*, but in most of the Protectorate *Eutermes* has not been observed either in its own *termitaria* or as an inquiline. Conquest of the *Cubitermes* nests appears to take place by infiltration by workers and soldiers, either from *Eutermes termitaria* or from captured *Cubitermes* nests. For a time a vertical section of the column may be occupied and walled off from the nest, but in most cases the two species were observed mingling amicably, and in these cases there was almost complete absence of *Cubitermes* soldiers, whilst *Eutermes* soldiers were present in great numbers. On the other hand *Cubitermes* workers were dominant.

3. *Cubitermes* is well represented all over Sierra Leone. There are at least four species, all of which build characteristic mushroom or sometimes phallic *termitaria* commonly observed in partial clearings, sometimes provided with a thatched protection and anointed with a gruel of flour and water. The shrine belongs to the women and is referred to as the "women's devil" (*Gaffe i nyhai* (Mende)). *Eutermes* on the other hand has never before been recorded from Sierra Leone and there is every reason to believe that it is a new arrival here, and that it is spreading rapidly at the expense of *Cubitermes* and it will be interesting to see how the status of these two termites alters in the next few years. *Eutermes* is not the distinguished architect that *Cubitermes* is, and its own *termitaria* are simply flattened domes. It is a noteworthy fact that the size of the galleries in *termitaria* are proportional to the size of the species to which they belong, and this is related to the strong thigmotaxis of the family. Yet *Eutermes* though a good deal smaller than *Cubitermes* makes no attempt to reduce the size of the galleries. According to information received from the Commonwealth Institute of Entomology, there are some thirty species of *Eutermes*, *Trinervitermes*, *Coarctotermes* and *Hospitalitermes* in West Africa, mostly at the eastern end of the range, though one species is recorded from the Gambia and another from French Guinea. It is therefore all the more remarkable that this Genus has not made its appearance in Sierra Leone before. It may be significant that the two localities where it has now been recorded, viz. Newton near Freetown and Tambaka Yobanji in the north-western part of the Protectorate are both areas in which farming operations have resulted in the degradation of forest to grassland or orchard bush.

4. Another observation worth recording is the large scale destruction of *Macrotermes* in the fire orchard country of the Tambakas by presumably annual burning. Here in the north of Sierra Leone burning is not confined to single farms once every few years, but involves the whole countryside every year. It is doubtful if this holocaust of *Macrotermes* is entirely beneficial. This is the only termite genus in Sierra Leone which constructs its *termitaria* with soil brought up from a considerable depth. The mounds are commonly found as many as ten to the acre and as an average *termitarium* is calculated to comprise some 500 cub. ft. of soil, it will be seen that this termite, by its excavations, must exercise a strong modifying influence on the top-soil, especially with regard to available minerals. All other local termites use top-soil in constructing their *termitaria*, and while they do some good in

accelerating the vegetational turnover, it is doubtful if they make up in any other way for the enormous harm they do. In conjunction with the Agricultural Chemist the soil from *Macrotermes* and *Cubitermes* termitaria were compared:—

	<i>Cubitermes</i>	<i>Macrotermes</i>
Colour	Dry, grey wet, black on heating, bright orange	Dry, pale brown wet, moderate brown on heating, bright orange
Texture	Fine crumbly open	Compact, plastic on wetting
Nitrogen	0.531 per cent	0.326 per cent
pH	6.6	6.6
Exchangeable bases	0.983	10.807

The pedological interpretations of these figures is outside the scope of this report, but it is evident that in discussing the influence of termites on soils different species must be distinguished. This has not always been done and many writers simply refer to termites as if there was only one specie in the world or as if all species had precisely the same habits.

ZONOCERUS VARIEGATUS

5. This destructive Acridid occurs annually in Sierra Leone. Hatching commences usually in September, adults appear in December, sexual maturity is attained during the ensuing dry season and the peak of oviposition is reached in March when the first storms usually break. The eggs remain dormant during the hot months of March, April and May which are punctuated with occasional storms of increasing frequency, and throughout the months of heavy rainfall June, July, August and September. A special study was made of this egg dormancy or diapause. In collaboration with the Agricultural Chemist, ether extracts of egg masses were made throughout the months of the diapause. It was found that the fat contents expressed as a percentage of dry matter remained high, between 12.2 and 23.5 throughout the months of May to September, but dropped to 6.2 per cent shortly before hatching was due to take place. The egg envelopes are completely waterproof to start with, but gradually deteriorate until they become water permeable. Attempts to induce early hatching by keeping egg masses well watered, however, failed so that there is evidently some other unknown factor involved. A complication is introduced by the fact that egg masses laid at the same time and even the individual eggs in an egg mass develop at different rates. They draw abreast on the threshold of hatching when the whole egg mass is ready to receive the stimulus which sets off eclosion. By establishing ten arbitrary but easily distinguishable stages of development, and dissecting a sample of the individual eggs of any egg mass it is possible to correlate the fat content with a particular peak of development.

6. The external ductless glands, the pleuropodia, whose functions are not fully known were investigated. They arise as hollow spheres of large thin-walled cells attached to the body wall behind the third coxæ about the time when the yolk is enclosed in the abdomen and later become flattened against the body wall. By the time the threshold of eclosion has been reached the membranous attachment of pleuropodia disintegrates and the pleuropodia are detached from the body of the insect. Both the pleuropodia and the amniotic fluid give a marked acid reaction and both are readily coagulated by heat.

7. The work on the egg diapause of similar acridids in North America and Australia is being closely followed.

TSETSE FLY INVESTIGATIONS

8. This investigation was continued and was mainly concerned with *G. palpalis*. The daily catches were analysed into three age-groups and the data so obtained have been found to provide an invaluable guide to seasonal bionomical differences. A check on this is provided by the percentage of unmated females. There proved to be a marked difference in the sex ratio of the three age-groups, so that comparative references to the ratio as an index of the scarcity of food are meaningless unless they are related to a particular age-group.

9. Of the 5,000 flies thus analysed some 2,000 were dissected in the course of the year to determine the incidence of trypanosome infection.

10. The method of dissection for the proboscis was that given by Lloyd and Johnson (B.E.R. Vol. 14, pp. 265-288) but for the proventriculus, salivary glands, and mid-gut, a new technique was used. *T. vivax* was by far the commonest with *T. congolense* much less frequent. This is in accord with the findings of previous workers. *T. gambiense* was not seen at all. Whereas previous records of infection were based on a few dissections over a short period of time, the present investigation extended over several seasons and involved a much larger total of flies. Consequently a new fact emerged; there is a remarkable seasonal fluctuation in infection, the incidence being high in the rains and low in the dries. In the past, workers have been led to somewhat optimistic conclusions regarding the incidence of infection in Sierra Leone by confining their investigations to the dry season. The cause of this seasonal fluctuation is not known. As was to be expected the incidence is lowest in the first age-group, in fact during the greater part of the year it is a fractional percentage. Similarly that of the second age-group is lower than that of the third age-group. A remarkable fact worth recording is the number of colonies of *T. vivax* found dead in the labrum during the month of December. There seems to be some factor actually hostile to the trypanosomes in the fly during this period which may be partly responsible for the low rate of infection.

11. Most of the flies were collected at Njala but occasional visits were made to different parts of the Protectorate and flies collected and dissected on the spot thus providing data for comparison with the Njala results. In addition two visits were paid to Fintonia where *G. longipalpis* is numerous most of the year round. This place is of peculiar interest in that here all three tsetse flies of Sierra Leone are found. This is also one of the few places in Sierra Leone where people complain of not being able to keep cattle owing to disease. This has been attributed to the presence of *G. longipalpis*; but there is another side to the question; the presence of *G. fusca* in this fire orchard country is in itself a sure indication of the prevalence of big game such as buffalo and elephant and it is quite possible that the real trouble is the presence of virulent strains of trypanosomes in these animals."

(d) PRODUCE INSPECTION

82. This branch of the department has been in existence since 1922, its purpose being to ensure that the main export produce is up to the standard required by overseas markets. In addition, it is responsible for seeing that export produce is stored throughout the country under proper conditions; for the checking of weights and measures; and for prosecutions in connection with all these matters. Recently the branch has been reorganised after the wartime hiatus.

83. In 1948, the Produce Inspection staff was increased by six examiners and at the end of the year consisted of one Inspector of Produce, one Assistant Inspector of Produce and 32 examiners. Even so, with the relatively complex communications, numerous trading centres and variety of produce in Sierra Leone, this staff has not proved adequate and the senior grades need strengthening.

84. The main produce inspected continued to be palm kernels, palm oil, ginger and piassava with a watching brief upon cocoa, coffee and groundnuts. Tonnage of these last three products, as for palm oil, increased considerably during 1948 and the time may not be far distant when legislation will have to be formulated for their full inspection. During 1948 details of the latest cocoa regulations were obtained from Nigeria and the Gold Coast, and, based upon the grading in force in these colonies in consultation with the local Chambers of Commerce, draft rules have been drawn up for future legislation. Experience during 1948, however, indicates that inspection of cocoa into various grades is unlikely to be effective unless there is also a corresponding grading of prices with a substantially lower price being paid for the poorer quality material.

85. Coffee regulations have been obtained from East Africa but it is considered that the time is not yet ready for their introduction into Sierra Leone. In the 1947/48 buying season, coffee for export to the United Kingdom was sold on a standard sample sent to the Ministry of Food. Up to date this system has appeared to work well and, unless tonnage shows a pronounced increase and general quality declines, this method will be continued.

86. Of the other produce inspected, namely ginger, piassava, palm kernels and palm oil, the quality has been well maintained and very few complaints have reached us from overseas.

87. Piassava has continued to be the most troublesome of all produce inspected although this has only applied to Sulima quality and not to Prime Sherbro. The difference in the two types is almost entirely due to the different methods of retting—Sulima being retted for 2–3 weeks only, as compared with 2–3 months for Prime Sherbro. The result is that Prime Sherbro is a naturally clean, strong fibre whereas Sulima has a great deal of pith attached, which weakens the fibre and appears to be hygroscopic in storage. Aggravating this difference is the long-standing habit, particularly in the Sulima—Pujehun area, of dealers purchasing any quality material at cheap rates in order to do their own cleaning. Towards the end of 1948, however, the difference in f.o.b. prices between Sulima and Sherbro quality was so marked, i.e. £20 per ton Sulima as against £63 per ton Sherbro, that there were welcome signs that some Sulima producers were being converted to longer retting and more careful preparation in order to produce Prime Sherbro quality.

88. Early in 1948, a Piassava Advisory Board was formed and has made several recommendations beneficial to the industry. The result is that, in up-country inspection, piassava of up to 12 per cent impurities is now allowed to be bought but that before export it must be cleaned up to 5 per cent impurities, only, with a compulsory inspection at port before final export. This up-country latitude was granted in response to many requests that producers and firms' buyers could not judge quality as fine as 5 per cent impurities. Since introducing this modification there have been no complaints from overseas but the danger exists particularly with the lower quality material, Sulima, that traders will take advantage of the concession and buy up material which cannot be brought up to standard. This, in fact, did occur in one area towards the end of the year. It is noticeable, however, that with properly prepared material of Prime Sherbro quality no such difficulty has arisen and it is hoped that progressively the Sulima production will switch-over to Prime Sherbro.

89. With building materials becoming more readily available to repair and build stores, more attention is now being paid by the Produce Inspection branch to the condition of produce stores, both at the ports and up-country. In Freetown a new deep-water quay is under construction and any erection of new produce stores will depend upon its completion. It is in the up-country stores that conditions are, in some cases, so deplorable. A collective effort in the next few years could effect a great improvement in storage conditions and consequent improvement in produce quality.

90. The tonnages of the main export crops inspected by the branch in 1947 and 1948 were:—

			1947	1948
Palm kernels	..	..	61,240	66,431
Palm Oil	..	..	637	2,208
Ginger	..	..	1,451	1,318
Piassava	..	..	2,958	2,160
Total	..	..	66,286	72,117

91. It was possible in 1948 to undertake the inspection of scales, weights and measures in many centres of the Protectorate. Certain illegal scales and weights which could not be corrected were seized and a number of prosecutions were instituted. Including those for offences against the Native Produce Ordinance, 84 convictions were obtained during the year.

(e) AGRICULTURAL EDUCATION

92. The training of potential Agricultural Instructors continued as in previous years at the Njala Training College. The Agricultural Course was in charge of Mr. T. P. Wheldon, Agricultural Officer, throughout the year, assisted by Mr. G. C. Taylor, Agricultural Superintendent. The following résumé of the year's work is extracted from the Principal's annual report for 1948:—

“Two agricultural groups were in residence throughout the year. The senior of the two, recruited in 1946, completed the third year of their course, the subjects being Agriculture, Animal Husbandry (Nutrition), Zoology (with Entomology), Plant Protection, Produce Preparation and Legislation, Surveying, English and Arithmetic. Examinations were set in all these subjects. Progress was fair, though the general standard reached was not as satisfactory as it might have been.

The second group, completed the first year of the course, which dealt with Soils, Botany, Climate and Vegetation, Labour Management, Surveying, Arithmetic and English. Examinations were set in these subjects, and the general standard was very good. The two students who had gained scholarships by good records as Junior Instructors in the Department and who were considerably below the academic standard of the remainder of the group which included two with London Matriculation and two more with Cambridge School Certificates, accepted the challenge given by the higher qualified, and by dint of really hard work were able to pass all but one of the examinations. The attitude of this group to the practical work on the farm is most encouraging and the progress made in farm management has been good.

Practical work on the farm was, as always, a feature of the year's work. Valuable experience and practice of the care necessary when planting and harvesting crops under statistical experiment was gained when the students assisted on the Departmental farm at Njala.

On the farm, the fourth annual strip was cultivated. This strip had been down to elephant grass for five years. An observational trial was laid down in this strip to determine the effect of treatment of an elephant grass ley on a subsequent rice crop. There were four treatments:

- (i) Complete removal of elephant grass stems and roots.
- (ii) Burning the stems on the plot, the ash incorporated, and the roots left *in situ*.
- (iii) Burning the stems on the plot, the ash incorporated, the roots dug up and left on the surface to rot.
- (iv) Stems and roots burned and the ash incorporated.

The four plots, each of which was approximately one-quarter of an acre, were broadcast with rice with small amounts of benniseed, guinea corn and pigeon pea inter-cropped as in native practice. Germination of the rice (variety Gbondobai) was good, but germination of a large number of self-sown *Centrosema plumieri* seeds necessitated early weeding. There was some loss of seedlings by rats and "bush fowl" and one or two small patches were resown. The trial was spoiled, however, not by *Centrosema* or by animal pests, but by a late germination of self-sown *Pueraria phaseoloides*, which appeared when the rice was too far advanced for further weeding, and the *Pueraria*, once away, had no difficulty in effectively strangling the greater part of the rice. One valuable lesson was learned from the Departmental farm in the need for sowing rice and other crops in rows to facilitate weeding through out the growth period, where there is a possibility of self-sown *Pueraria*, with its tendency for late germination, appearing. As *Pueraria* is used as a cover crop in the permanent strips on the College farm, the appearance of *Pueraria* in the cultivated grass strips is a probability rather than a possibility. The treatments will be repeated in the fifth annual strip in 1949, and the rice will be dibbled in rows, and a variety of *Oryza glaberrima* will be sown, as well as a variety of *Oryza sativa*, since *Oryza glaberrima* is commonly used after grass fallows in the grassland areas of the north. The third annual strip which was cultivated in 1947 was planted with elephant grass. The young oil-palms in the third permanent strip were satisfactory as was the yield of the citrus in the first permanent strip. A few of the fruit trees in the fifth permanent strip (mixed fruit plantation) fruited for the first time and it is expected that the mangoes, avocado pears and cashews will fruit in 1949. The yield of coffee from the coffee strip was very poor. There is too much shade in this strip, and this shade will be thinned out and the trees pruned in 1949. Cultivation of native and exotic vegetables continued in the nursery and a number of beds were planted with mangoes, sour orange and avocado pears for budding and grafting practice.

Routine management of rabbits, poultry and calves continued, and the students had ample opportunity to gain experience in handling small stock. The livestock section of the Department of Agriculture farm at Njala was used by the senior group, each student spending five hours each week on milking and pig management. Unfortunately the pig pen at the College was not finally completed until late in the term, and by that time, with the end of year examinations approaching, it was decided to await until the return of the students in 1949 before obtaining a young gilt from the Department of Agriculture."

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Director of Agriculture.

DEPARTMENT OF AGRICULTURE,
NJALA,
via MANO.

30th July 1949

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